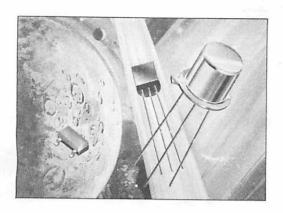
MOTOROLA INC.



SMALL-SIGNAL TRANSISTOR DATA





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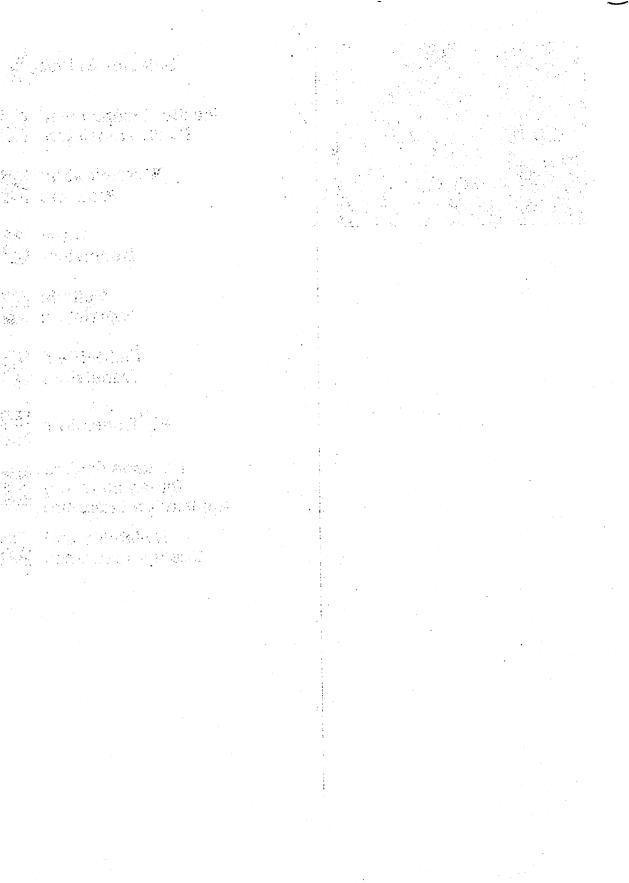
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MOTOROLA

SMALL-SIGNAL TRANSISTORS

Prepared by Technical Information Center

This publication presents technical information for the several product families that comprise the Motorola small-signal transistor line. The families include both bipolar and field-effect transistors. These are available in a variety of packages; metal can, plastic, and microminiature. Complete device specifications and typical performance curves are given on individual data sheets, which are grouped by the various families.

A quick comparison of performance characteristics is presented in the easy-to-use selector guides in the first section. The tables will assist in the selection of the proper transistor for a specific application.

Separate sections are included to describe package outline drawings, and to clarify the mysteries of high reliability processing and testing.

The information in this book has been carefully checked and is believed to be accurate; however, no responsibility is assumed for inaccuracies. Furthermore, this information does not convey to the purchaser of semiconductor devices any license under the patent rights to the manufacturer.

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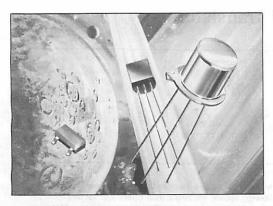
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The following selector guides highlight transistors that have emerged as the best values in their various categories. Semiconductors are manufactured by "batch" processes; therefore, each "batch" may yield devices with widely varying parameters, creating "families."

A large selection of plastic-encapsulated transistors is offered (TO-92, 1 Watt TO-92, SOT-23, SOT-89, Duals, and Quads).

For those applications where higher power dissipation and hermeticity are required, Motorola offers a full line of transistors in several metal-can packages.

FET's include devices developed for operation from dc to UHF in switching and amplifying applications.

A broad line of high frequency (RF) transistors with F7's up to 8 GHz are included for amplifiers, oscillators, mixers and switching applications.

Devices which are qualified to JAN, JANTX, JANTXV, and JANS high reliability specifications are so noted in the applicable selector guides.

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Plastic-Encapsulated Small-Signal Transistors





Motorola's small-signal TO-92 plastic transistors encompass hundreds of devices with a wide variety of characteristics for general purpose, amplifier and switching applications. The popular high-volume TO-92 package combines proven reliability, performance, economy and convenience to provide the perfect solution for industrial and consumer design problems. All Motorola TO-92 devices are laser marked for ease of identification and shipped in antistatic containers, as part of Motorola's ongoing practice of maintaining the highest standards of quality and reliability.

In addition to the standard TO-92 devices listed in the following tables, Motorola also offers special electrical selections of these devices. Please contact your Motorola Sales Representative regarding any special requirements you may have.

In each of the following tables, the major specifications of the TO-92 transistor are given for easy comparison.

Motorola TO-92 transistors are available in the radial or axial tape and reel formats. Lead forming to fit TO-5 or TO-18 sockets is also available.

TABLE 1. General-Purpose Transistors

These general-purpose transistors are designed for small-signal amplification from dc to low radio frequencies. They are also useful as oscillators and general-purpose switches. The transistors are listed in order of decreasing breakdown voltage, V(BR)CEO-

| $P_D @ T_A = 25^{\circ}C = 625$ | mW) | 1 |
|---------------------------------|-----|---|
|---------------------------------|-----|---|

| Device a | and Polarity | V(BR)CEO | F _T (| | lc | H | FE | <u>@</u> . |
|--------------------|--------------|--------------|------------------|----------|-----------|-----|----------|------------|
| NPN | PNP | Volts Min | MHz Min | IC mA | mA Max | Min | Max | IC mA |
| MPS8099 | MPS8599 | 80 | 150 | 10 | 200 | 100 | 300 | 1.0 |
| MPS-A06 | MPS-A56 | 80 | 100 | 10 | 500 | 50 | _ | 100 |
| MPS8098 | MPS8598 | 60 | 150 | 10 | 200 | 100 | 300 | 1.0 |
| MPS-A05 | MPS-A55 | 60 | 100 | 10 | 500 | 50 | – | 100 |
| MPS651 | MPS751 | 60 | 75 | 50 | 2000 | 40 | l – | 2000 |
| 2N3904 | 2N3906 | 40 | 300 | 10 | 200 | 100 | 300 | 10 |
| 2N4401 | 2N4403 | 40 | 250 | 20 | 600 | 100 | 300 | 150 |
| 2N3903 | 2N3905 | 40 | 250 | 10 | 200 | 50 | 150 | 100 |
| 2N4400 | 2N4402 | 40 | 200 | 20 | 600 | 50 | 150 | 150 |
| MPS-A20 | MPS-A70 | 40 | 125 | 5.0 | 100 | 40 | 400 | 5.0 |
| MPS650 | MPS750 | 40 | 75 | 50 | 2000 | 40 | _ | 2000 |
| MPS6531 | MPS6534 | 40 | 390† | 50 | 600 | 90 | 270 | 100 |
| MPS2222 | MPS2907 | 30 | 250 | 20 | 600 | 100 | 300 | 150 |
| 2N4123 | 2N4125 | 30 | 250 | 10 | 200 | 50 | 150 | 2.0 |
| MPS3704 | MPS3702 | 30 | 100 | 50 | 600 | 100 | 300 | 50 |
| MPS6513 | MPS6517 | 30 | 330† | 10 | 100 | 90 | 180 | 2.0 |
| 2N4124 | 2N4126 | 25 | 300 | 10 | 200 | 120 | 360 | 2.0 |
| MPS6514 | MPS6518 | 25 | 480t | 10 | 100 | 150 | 300 | 2.0 |
| MPS6515 | MPS6519 | 25 | 480 | 10 | 100 | 250 | 500 | 2.0 |
| MPS5172 | WIF 303 19 | 25 | 1 | | 100 | 100 | 500 | 10 |
| | MPS6562 | 25 | 60 | 10 | 500 | 50 | 200 | 600 |
| MPS6560 MPS6601 | MPS6651 | 25 | 100 | 50 | 1000 | 30 | 150 | 1000 |

| 1 WATT TO-02 | (TO-226AF) (Pp | @ TA = | : 25°C = 1.0 W) |
|--------------|----------------|--------|-----------------|

| MPS6717 | MPS6729 | 80 | 50 | 200 | 500 | 80 | _ | 50 |
|---------|---------|------|------|------|------|----|---------------|------|
| | | 80 | 50 | 200 | 500 | 80 | _ | 50 |
| MPSW06 | MPSW56 | | 50 | 200 | 500 | 80 | _ | 50 |
| MPS6716 | MPS6728 | 60 | | | | 80 | | 50 |
| MPSW05 | MPSW55 | 60 | 50 | 200 | 500 | | i – | 1000 |
| MPS6715 | MPS6727 | 40 | . 50 | 50 | 1000 | 50 | _ | |
| MPSW01A | MPSW51A | 40 | 50 | 50 | 1000 | 50 | <u> </u> | 1000 |
| | MPS6726 | 30 | 50 | 50 | 1000 | 50 | l — | 1000 |
| MPS6714 | | 30 | 50 | 50 | 1000 | 50 | l | 1000 |
| MPSW01 | MPSW51 | ı 3∪ | 1 30 | , 50 | | | 1 | |

†Typ

PLASTIC ENCAPSULATED SMALL-SIGNAL TRANSISTORS (continued)

TABLE 2. High-Speed Saturated Switching Transistors

The transistors listed in this table are specially optimized for high-speed saturated switches. They are heavily gold doped and processed to provide very short switching times and low output capacitance (below 6 pF). The transistors are listed in order of decreasing turn-on time (t_{on}).

| Device Type | t _{on} ns Max | & toff ns Max | @ 'C mA | V(BR)CEO Volts Min | h _{FE} | e IC mA | VCE(sat) Volts Max | @ lc | & IB | fy @ | lc |
|----------------|------------------------------|---------------------|-------------------|--------------------------|-----------------|-------------------|--------------------------|----------|-----------|------|----|
| IPN . | 1 | 1 11142 | | | 1 191111 | 11110 | INGA | <u> </u> | mA | Min | mA |
| 2N4264 | 25 | 35 | 10 | 15 | 40 | 10 | 0.22 | 10 | 1.0 | 300 | 10 |
| 2N4265 | 25 | 35 | 10 | 12 | 100 | 10 | 0.22 | 10 | 1.0 | 300 | 10 |
| MPS3646 | 18 | 28 | 300 | 15 | 30 | 30 | 0.2 | 30 | 3.0 | 350 | 30 |
| MPS2369 | 12 | 18 | 10 | 15 | 40 | 10 | 0.25 | 10 | 1.0 | 500 | 10 |
| NP | | | | | | | | | | | |
| MPS3640 | 25 | 35 | 50 | 12 | 30 | 10 | 0.2 | 10 | 1.0 | 500 | 10 |
| MPS4258 | 15 | 20 | 10 | 12 | 30 | 50 | 0.15 | 10 | 1.0 | 700 | 10 |
| 2N5771 | 15 | 20 | 10 | 15 | 50 | 10 | 0.18 | 10 | 1.0 | 850 | 10 |

TABLE 3. RF/UHF/VHF Amplifiers and CATV Transistors

The transistors listed below are high performance, high frequency standard transistors. The transistors are listed in order of decreasing f_T min.

| Device | | lHz (| @ | C _{cb} | V(BR)CEO Volts | G _{pe} | NF (| <u> </u> | V | |
|---------|-----|-------|-------|-----------------|-------------------|-----------------|------|----------|-------------|--------------|
| Туре | Min | Тур | mA | Max | Min | Min | Max | MHz | VAGC Min | Reduction dB |
| MPS5179 | 900 | | 5.0 | 1.0 | 12 | 15 | 4.5 | 200 | | |
| MPS-H17 | 800 | 1600 | 5.0 | 0.9 | 15 | 24† | 6.0 | 200 | | |
| MPS6543 | 750 | 1100 | 4.0 | 1.0 | 25 | | "" | -00 | | |
| MPS-H10 | 650 | 1500 | 4.0 | 0.65* | 25 | ĺ | l | ł . | | |
| MPS-H11 | 650 | 1400 | 4.0 | 0.7 | 25 | | ļ | | | |
| MPS6547 | 600 | 1100 | 2.0 | 0.35† | 25 | | | | | |
| MPS918 | 600 | 800 | 4.0 | 1.7 | 15 | 15 | 6.0 | 60 | | |
| MPS3563 | 600 | 800 | 8.0 | 1.7 | 12 | 14 | 5.5 | - 55 | | |
| MPS3866 | 500 | 1 | 50 | 1 | 30 | 10 | | | 1 | |
| MPS-H08 | 400 | 700 | 3.0 | 0.3* | 30 | 14 | 3.5 | 200 | 5.0** | 30 |
| MPS-H34 | 500 | 700 | 15 | 0.32 | 45 | | 0.0 | 200 | 3.0 | 30 |
| MPS6539 | 500 | 1000 | 4.0 | 0.7 | 20 | | 4.5 | 100 | | |
| 2N5222 | 450 | 1000 | 4.0 | 1.3 | 15 | l . | | 100 | | |
| MPS-H07 | 400 | 700 | 3.0 | 0.3* | 30 | 18 | 3.2 | 100 | 5.0 | 30 |
| MPS-H24 | 400 | 800 | 8.0 | 0.36 | 30 | ' | 0.2 | | 3.0 | 30 |
| MPS-H20 | 400 | 750 | 4.0 | 0.65 | 30 | 1 1 | | | | |
| MPS6540 | 350 | 700 | 2.0 | 0.65 | 30 | | | | Į. | |
| MPS-H32 | 300 | 450 | 4.0 | 0.22 | 30 | 22.5 | 3.3† | 45 | 5.5† | 20 |
| MPS-H30 | 300 | 450 | 4.0 | 0.65 | 20 | 22.5 | 6.0 | 45 | 4.4 | 30 30 |
| MPS3693 | 200 | 400 | 10 | 3.5 | 45 | | 4.0† | 1.0 | 7.7 | 30 |
| MPS3694 | 200 | 400 | 10 | 3.5 | 45 | | 4.0† | 1.0 | l | |
| MPS-H04 | 80 | 120 | 1.5 | 1.6 | 80 | | 2.0 | 1.0 | l | |
| MPS-H05 | 80 | 120 | 1.5 | 1.6 | 80 | | 2.0 | 1.0 | | |
| NP | | | | | | | | | | |
| MPS-H81 | 600 | 700 | 5.0 | 0.65* | 20 | | | | | |
| 2N5208 | 300 | 600 | 2.0 | 1.0 | 25 | 22 | 3.0 | 100 | | |
| MPS-H54 | 80 | 130 | 1.5 | 1.6 | 80 | | 2.0 | 1.0 | | |
| MPS-H55 | 80 | 130 | 1.5 | 1,6 | 80 | | 0 | 7.0 | j | |

^{*}C_{CB} "IAGC †Typ

PLASTIC ENCAPSULATED SMALL-SIGNAL TRANSISTORS (continued)

TABLE 4. Darlington Transistors

Darlington amplifiers are cascade transistors used in applications requiring very high gain and input impedance. These devices have monolithic construction and are listed in order of decreasing voltage, V(BR)CES-

| Device a | nd Polarity | V(BR)CES | (|) | 1c | ft @ | | | @ | |
|------------|--------------|--------------|------------|----------|-----------|------------|----------|--------------|----------|----------|
| NPN | PNP | Volts Min | hFE Min | IC mA | mA Max | MHz Min | IC mA | Volts Max | IC mA | lg mA |
| MPS-A29 | † | 100 | 10000 | 100 | 500 | 125 | 10 | 2.0 | 100 (| 0.1 |
| MPS-A28 | I. | 80 | 10000 | 100 | 500 | 125 | 10 | 2.0 | 100 | 0.1 |
| MPS-A27 | Ì | 60 | 10000 | 100 | 500 | 125 | 10 | 1.5 | 100 | 0.1 |
| ni o ne | MPSA77 | 60 | 10000 | 100 | 300 | 125 | 10 | 1.5 | 100 | 0.1 |
| MPS-A26 | 1 1011 07117 | 50 | 10000 | 100 | 500 | 125 | 10 | 1.5 | 100 | 0.1 |
| WIT OFFICE | MPSA76 | 50 | 10000 | 100 | 300 | 125 | 10 | 1.5 | 100 | 0.1 |
| 2N6426 | 1111 07170 | 40 | 30000 | 100 | 500 | 150 | 10 | 1.5 | 500 | 0.5 |
| 2N6427 | | 40 | 20000 | 100 | 500 | 130 | 10 | 1.5 | 500 | 0.5 |
| MPSA25 | Ì | 40 | 10000 | 100 | 500 | 125 | 10 | 1.5 | 100 | 0.1 |
| WIFGAZO | MPSA75 | 40 | 10000 | 100 | 300 | 125 | 10 | 1.5 | 100 | 0.1 |
| MPSA14 | MPSA64 | 30 | 20000 | 100 | 300 | 125 | 10 | 1.5 | 100 | 0.1 |
| MPSA13 | MPSA63 | 30 | 10000 | 100 | 300 | 125 | 10 | 1.5 | 100 | 0.1 |
| MPSD04 | MPSD54 | 25 | 1000 | 100 | 300 | 100 | 10 | 1.0 | 100 | 0.1 |
| MPSA12 | MPSA62 | 20 | 20000 | 10 | 300 | | | 1.0 | 10 | 0.01 |
| WATT TO | -92 | | | | | | | | | |
| MPS6725 | T | 50 | 25K | 200 | 1000 | 100 | 200 | 1.5 | 1000 | 2.0 |
| MPS6724 | Ì | 40 | 25K | 200 | 1000 | 100 | 200 | 1.5 | 1000 | 2.0 |
| MPSW45 | | 40 | 25K | 200 | 1000 | 100 | 200 | 1.5 | 1000 | 2.0 |
| MPSW14 | MPSW64 | 3.0 | 20K | 100 | 1000 | 125 | 10 | 1.5 | 100 | 0.1 |
| MPSW13 | MPSW63 | 30 | 10K | 100 | 1000 | 125 | 10 | 1.5 | 100 | 0.1 |

TABLE 5. Low-Noise Amplifier Transistors

The small-signal transistors listed in this table are characterized for low-noise amplification at low frequencies. The transistors are listed in decreasing order of noise figure (NF).

| | NF @ | | BV(BR)CEO | @ | · | fr @ | |
|-------------|---------|---------|-----------|-----|------|-------------|-----|
| | dB l | | Volts | hFE | lc l | MHz | lc |
| Device Type | Тур | * | Min | Min | mA | Min | mA |
| PN | | | | | | | |
| 2N6428 | 6.0 | Audio | 50 | 250 | 10 | 100 | 1.0 |
| 2N4123 | 6.0 | Audio | 30 | 50 | 2.0 | 250 | 10 |
| 2N6429 | 5.0 | Audio | 45 | 500 | 10 | 100 | 1.0 |
| 2N4124 | 5.0 | Audio | 25 | 120 | 2.0 | 300 | 10 |
| 2N6428A | 4.0 Max | Audio | 50 | 250 | 10 | 100 | 1.0 |
| 2N6429A | 3.5 Max | Audio | 45 | 500 | 10 | 100 | 1.0 |
| 2N5209 | 3.0 Max | Audio | 50 | 150 | 10 | 30 | 0.5 |
| 2N5088 | 3.0 | Audio | 30 | 300 | 10 | 50 | 0.5 |
| MPS6520 | 3.0 | Audio | 25 | 200 | 2.0 | 390† | 2.0 |
| MPS6521 | 3.0 | Audio | 25 | 300 | 2.0 | 390† | 2.0 |
| 2N5210 | 2.0 Max | Audio | 50 | 250 | 10 | 30 | 0.5 |
| MPS8097 | 2.0 Max | Audio | 40 | 250 | 0.1 | 200 | 10 |
| 2N5089 | 2.0 Max | Audio | 25 | 400 | 10 | 50 | 0.5 |
| MPSA18 | 1.5 Max | Audio | 45 | 500 | 10 | 100 | 1.0 |
| MPSA09 | 1.4 | 1.0 kHz | 50 | 100 | 0.1 | 30 | 0.5 |
| PNP | | | | | | | |
| 2N4125 | 5.0 | Audio | 30 | 50 | 2.0 | 200 | 10 |
| 2N4126 | 4.0 | Audio | 25 | 120 | 2.0 | 250 | 10 |
| 2N5086 | 3.0 | Audio | 50 | 150 | 10 | 40 | 0.5 |
| MPS6522 | 3.0 | Audio | 25 | 200 | 2.0 | 340† | 2.0 |
| MPS6523 | 3.0 | Audio | 25 | 300 | 2.0 | 340† | 2.0 |
| MPS4249 | 3.0 | 1.0 kHz | 60 | 100 | 10 | 100 | 1.0 |
| 2N5087 | 2.0 | Audio | 60 | 250 | 10 | 40 | 0.5 |
| MPS4250 | 2.0 | 1.0 kHz | 40 | 250 | 10 | 250 | 1.0 |
| *MPS4250A | 2.0 | 1.0 kHz | 60 | 250 | 0.1 | 250 | 1.0 |

^{*}Audio = 10 Hz to 15.7 kHz.

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PLASTIC ENCAPSULATED SMALL-SIGNAL TRANSISTORS (continued)

TABLE 6. High-Voltage Transistors

These high-voltage transistors are designed for driving neon bulbs and Nixle* indicator tubes, for direct line operation, and for other applications requiring high-voltage capability at relatively low collector current. The devices are listed in order of decreasing breakdown voltage, V(BR)CEO-

| Device Type | V(BR)CEO Volts Min | ic Amp* Max | hre | @ IC mA | VCE(set) Volts Max | IC mA | å lg mA | f _T (| e lc |
|----------------|--------------------------|-------------------|-----|-------------------|--------------------------|----------|----------|------------------|-------------|
| IPN | | · | | | | | | · · · · · · | |
| MPS-A44 | 400 | 0.3 | 50 | 10 | 0.75 | 50 | 5.0 | 20 | 10 |
| 2N6517 | 350 | 0.5 | 30 | 30 | 0.30 | 10 | 1.0 | 40 | 10 |
| MPS-A45 | 350 | 0.3 | 50 | 10 | 0.75 | 50 | 5.0 | 20 | 10 |
| 2N6516 | 300 | 0.5 | 45 | 30 | 0.30 | 10 | 1.0 | 40 | 10 |
| MPS-A42 | 300 | 0.5 | 40 | 10 | 0.5 | 20 | 2.0 | 50 | 10 |
| 2N6515 | 250 | 0.5 | 50 | 30 | 0.30 | 10 | 1.0 | 40 | 10 |
| MPS-A43 | 200 | 0.5 | 40 | 10 | 0.4 | 20 | 2.0 | 50 | |
| MPS-D01 | 200 | 0.1 | 20 | 30 | J | | 2.0 | 40 | 10 |
| 2N5551 | 160 | 0.6 | 80 | 10 | 0.15 | 10 | 1.0 | 100 | 10 |
| 2N5550 | 140 | 0.6 | 60 | 10 | 0.15 | 10 | 1.0 | 100 | 10 |
| MPS-L01 | 120 | 0.15 | 50 | 10 | 0.70 | " | 1 '.0 | 60 | 10 |
| WATT TO-92 | ! | | | 1 | | ł | <u> </u> | 1 00 | 1 10 |
| MPS6735 | 300 | 0.3 | 40 | 10 | 2.0 | 20 | 2.0 | 50 | 1 40 |
| MPSW10 | 300 | 0.3 | 40 | 30 | 0.75 | 30 | 3.0 | 45 | 10 |
| MPSW42 | 300 | 0.3 | 40 | 30 | 0.50 | 20 | 2.0 | 50 | |
| MPS8734 | 250 | 0.3 | 40 | 10 | 2.0 | 20 | 2.0 | 50 | 10 |
| MPSW43 | 200 | 0.3 | 50 | 30 | 0.4 | 20 | 2.0 | 50 | 10 |
| MPS6733 | 200 | 0.3 | 40 | 10 | 2.0 | 20 | 2.0 | 50 | 10 |
| NP | | | | | | | 2.0 | 1 30 | 10 |
| 2N6520 | 350 | 0.5 | 30 | 30 | 0.30 | 10 | 1.0 | | |
| 2N6519 | 300 | 0.5 | 45 | 30 | 0.30 | 10 | 1.0 | 40 | 10 |
| MPS-A92 | 300 | 0.5 | 40 | 10 | 0.8 | 20 | 2.0 | 40 | 10 |
| 2N6518 | 250 | 0.5 | 50 | 30 | 0.30 | 10 | 1.0 | 50 | 10 |
| MPS-A93 | 200 | 0.5 | 40 | 10 | 0.7 | 20 | 2.0 | 40 | 10 |
| MPS-D51 | 200 | 0.1 | 20 | 30 | i | 20 | 2.0 | 50 40 | 10 |
| 2N5401 | 150 | 0.6 | 60 | 10 | 0.5 | 50 | 0.5 | | 10 |
| 2N5400 | 120 | 0.6 | 40 | 10 | 0.5 | 50 | 0.5 | 100 | 10 |
| MPS-L51 | 100 | 0.6 | 40 | 50 | 0.25 | 10 | 1.0 | 100 | 10 |
| WATT TO-92 | | | | | 5.20 | | 1.0 | 1 60 | 10 |
| MPSW60 | 300 | 0.3 | 40 | 30 | 0.75 | 20 | | | |
| MPSW92 | 300 | 0.3 | 25 | 30 | 0.75 | 20 | 2.0 | 60 | 10 |
| MPSW93 | 200 | 0.3 | 30 | 30 | 0.50 | 20 | 2.0 | 50 | 10 |
| | | | 55 | | 0.40 | 20 | 2.0 | 50 | 10 |

TABLE 7. Choppers

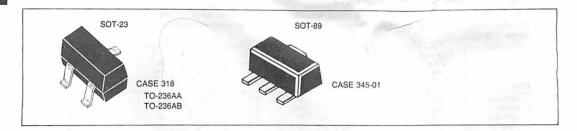
Devices are listed in decreasing (V(BR)EBO

| Device | V(BR)FBO Volts | l _C | . | | VCE(sat) | | 3. | fr @ | |
|---------|-------------------|----------------|------------|----------|--------------|----------|----------------------|-------------|-------------|
| Туре | Min | Max | hFE Min | IC mA | Volts Max | IC mA | ^t B mA | MHz | lC mA |
| IPN | | | | | | | | | ша |
| MPSA17 | 15 | 100 | 200 | 5.0 | 0.25 | 10 | 1.0 | | |
| MPSA16 | 12 | 100 | 200 | 5.0 | 0.25 | 10 | 1.0 | 100 80 | 5.0 5.0 |
| NP | | | | | | | | | 3.0 |
| MPS404A | 25 | 150 | 30 | 12 | 0.20 | 24 | | | |
| MPS404 | 12 | 150 | 30 | 12 | 0.20 | 24 | 1.0 1.0 | 1 1 | |

TABLE 8. Dual Diodes

Dual diodes designed for use in low cost blasing, steering, and voltage doubler applications including series, common cathode and common anode diodes.

| Device Type | Description | V _(BR) (Volts Min | ⁽⁾ I(BR) μΑ | lR (μA Max | @ VR Volts | V _F Volts Min/Max | @ IF mA | C _{VR} = 0 pF Max | t _{rr} ns Max |
|----------------|----------------|-------------------------------------|------------------------------|-------------------|------------|------------------------------------|-------------------|----------------------------------|------------------------------|
| MSD6100 | Switching | 100 | 100 | 0.1 | 50 | 0.67/0.82 | 10 | 1.5 | 4.0 |
| MSD6102 | Common Cathode | 70 | 100 | 0.1 | 50 | 0.67/1.0 | 10 | 3.0 | 100 |
| MSD6150 | Common Anode | 70 | 100 | 0.1 | 50 | /1.0 | 10 | 8.0 | 100 |



Microminiature Space Saving Alternatives for Discrete Devices

A wide variety of discrete components from Motorola's repertoire of reliability-proven semiconductor processes and geometries are available in SOT (Small Outline Transistor) packages. Products include Bipolar and Field-Effect Transistors; Switching, Zener and Varactor Diodes; and Silicon Controlled Rectifiers. The surface-mounted SOT devices are currently being used by circuit designers on Printed Circuit Boards and Ceramic Substrate. Some of the significant features of the SOT devices are:

- liComplete Pretest Capability all SOT's are 100% electrically tested.
- Handling and Assembly Ease SOT's can be placed on substrates either manually or by using automated handling equipment.
- Reliability SOT's are subjected to the same rigid reliability test performed on all Motorola plastic packages.
- Small Size/Less Weight Considerable size reduction and weight-saving is achieved in circuit designs using SOT technology.
- Broad Line Currently, Motorola offers over 250 standard discrete devices in the SOT packages. (Inquiries regarding customers' special requirements are invited.)
- Marking Capability A multi-digit code is laser marked on every SOT device.

- Multi-Sources Although Motorola was the first domestic supplier of SOT's, today there are several U.S. manufacturers, as well as many foreign sources for these devices.
- Packaging Motorola standard shipping method for SOT's is in vials; additionally, in conjunction with the industry trend to use automatic placement equipment for microminiature components, Motorola offers the SOT-23 packaged in the 8mm tape and reel format.
- Standard SOT-23 VS Low Profile SOT-23 Motorola offers both the standard SOT-23 outline (TO-236AA) and the new "Low Profile" SOT-23 (TO-236AB). The only difference is the clearance from the bottom of the package to the surface of the substrate:

| | Millim | neters | Inches | | |
|--------------------|--------|--------|--------|--------|--|
| Device | Min | Max | Min | Max | |
| Standard SOT-23 | 0.10 | 0.25 | 0.004 | 0.0098 | |
| Low Profile SOT-23 | 0.01 | 0.10 | 0.0005 | 0.0040 | |

The "Low Profile" package is primarily designed for customers using two-sided printed circuit boards with the SOT-23's mounted on the "bottom side" of the board, and with the nonsurface mounted device on the "top side." Contact your Motorola representative for ordering instructions on "Low Profile" SOT-23's.

TABLE 1. General-Purpose SOT-23 Transistors

Pinout: 1-Base, 2-Emitter, 3-Collector

Devices are listed in order of descending breakdown voltage.

NPN

| | | | | hFE | | fT |
|-------------|---------|----------------------|-----|-----|-----------|-----------|
| Device Type | Marking | V _{BR(CEO)} | Min | Max | @ IC (mA) | Min (MHz) |
| BCX70K | AK | 45 | 380 | 630 | 2 | 125 |
| BCX70J | AJ | 45 | 250 | 460 | 2 | 125 |
| 3CW72 | K2 | 45 | 200 | 450 | 2 | _ |
| BCX70H | AH | 45 | 180 | 310 | 2 | 125 |
| BCW66G | EG | 45 | 160 | 400 | 100 | 100 |
| BCX70G | AG | 45 | 120 | 220 | 2 | 125 |
| BCW71 | K1 | 45 | 110 | 220 | 2 | _ |
| BCW66F | EF | 45 | 100 | 250 | 100 | 100 |
| BCX19 | U1 | 45 | 100 | 600 | 100 | 200 |
| MMBT930 | 1X | 45 | 100 | 300 | 1 | 30 |
| MMBC1623L7 | L7 | 40 | 300 | 600 | 1 | 200 |
| MMBC1623L6 | L6 | 40 | 200 | 400 | 1 | 200 |
| MMBC1623L5 | L5 | 40 | 135 | 270 | 1 | 200 |
| BSS79C | CF | 40 | 100 | 300 | 150 | 250 |
| MMBT2222A | 1P | 40 | 100 | 300 | 150 | 200 |
| MMBT3904 | 1A | 40 | 100 | 300 | 10 | 200 |

TABLE 1. General-Purpose SOT-23 Transistors (continued)Pinout: 1-Base, 2-Emitter, 3-Collector

Devices are listed in order of descending breakdown voltage.

NPN

| | İ | | | hFE | | fŢ |
|-------------|---------|----------|-----|----------|-----------|------------|
| Device Type | Marking | VBR(CEO) | Min | Max | @ IC (mA) | Min (MHz) |
| MMBT4401 | 2X | 40 | 100 | 300 | 150 | 250 |
| MMBC1623L4 | . L4 | 40 | 90 | 180 | 1 1 | 200 |
| MMBC1623L3 | L3 | 40 | 60 | 120 | 1 1 | 200 |
| MMBT3903 | . 1Y | 40 | 50 | 150 | 10 | 250 |
| BSS79B | CE | 40 | 40 | 120 | 150 | 250 |
| MMBTA20 | 1C | 40 | 40 | 400 | 5 | 125 |
| MMBC1622D8 | D8 | 35 | 450 | 900 | 5 | 100 |
| MMBC1622D7 | D7 | 35 | 300 | 600 | 5 | 100 |
| MMBC1622D6 | D6 | 35 | 200 | 400 | 5 | 100 |
| BCW60D | AD | 32 | 380 | 630 | 2 | 125 |
| BCW60C | AC | 32 | 250 | 460 | 2 | 125 |
| BCW65C | EC | 32 | 250 | 630 | 100 | 100 |
| BCW60B | AB | 32 | 180 | 310 | 2 | 125 |
| BCW65B | EB | 32 | 160 | 400 | 100 | 100 |
| BCW60A | AA | 32 | 120 | 220 | 2 | 125 |
| BCW65A | EA | 32 | 100 | 250 | 100 | 100 |
| MMBT2222 | 1B | 30 | 100 | 300 | 150 | 250 |
| MMBB601T | ZA | 25 | 400 | 650 | 2 | |
| BCW20 | U2 | 25 | 100 | 600 | 100 | l <u> </u> |
| MMBT4124 | zc | 25 | 60 | <u> </u> | 50 | 300 |
| BCW33 | D3 | 20 | 420 | 00 | 2 | " |
| BCW32 | D2 | 20 | 200 | 450 | 2 | _ |
| BCW31 | D1 | 20 | 110 | 220 | 2 | _ |

PNP

| | ł | İ | | ptE | | fT |
|-------------|---------|----------|------------|-----|-----------|-----------|
| Device Type | Marking | VBR(CEO) | Min | Max | @ IC (mA) | Min (MHz) |
| BSS82C | CM | 60 | 100 | 300 | 150 | 100 |
| MMBT2907A | 2F | 60 | 100 | 300 | 150 | 200 |
| MMBA811C8 | C8 | 45 | 450 | 900 | 5 | 50 |
| BCX71K | BK | 45 | 380 | 630 | 2 | == |
| MMBA811C7 | C7 | 45 | 300 | 600 | 5 | 50 |
| BCX71J | BJ | 45 | 250 | 460 | 2 | == |
| BCW70 | H2 | 45 | 215 | 500 | 2 | _ |
| MMBA811C6 | Ċ6 | 45 | 200 | 400 | 5 | 50 |
| BCX71H | BH | 45 | 180 | 310 | 2 | == |
| BCW68G | DG | 45 | 160 | 400 | 100 | 100 |
| MMBA811C5 | C5 | 45 | 135 | 270 | 5 | 50 |
| BCW69 | H1 | 45 | 120 | 260 | 2 | - 2 |
| BCX71G | BG | 45 | 120 | 220 | 2 | _ |
| BCW68F | DF | 45 | 100 | 250 | 100 | 100 |
| 3CX17 | T1 | 45 | 100 | 600 | 100 | 100 |
| MMBA813S4 | S4 | 45 | 100 | 200 | 50 | 100 |
| MMBA813S3 | S3 | 45 | 75 | 150 | 50 | 100 |
| MMBA813S2 | S2 | 45 | 50 | 100 | 50 | 100 |
| MMBA812M7 | M7 | 40 | 300 | 600 | 1 | 150 |
| MMBA812M6 | M6 | 40 | 200 | 400 | 1 : | |
| MMBA812M5 | M5 | 40 | 135 | 270 | 1 : | 150 |
| MBT2907 | 2B | 40 | 100 | 300 | 150 | 150 |
| MMBT3906 | 2A | 40 | 100 | 300 | 10 | 200 |
| MMBT4403 | 2T | 40 | 100 | 300 | 150 | 250 |
| MMBA812M4 | M4 | 40 | 90 | 180 | 1 | 200 |
| VMBA812M3 | M3 | 40 | 60 | 120 | ; | 150 |
| BSS80B | l ch | 40 | 40 | 120 | 150 | 150 |
| SSS80C | l ä | 40 | 40 | 120 | | 200 |
| MBTA70 | 20 | 40 | 40 | 400 | 150 5 | 200 |
| CW61D | BD | 32 | 380 | 630 | 2 | 125 |
| SCW61C | BC | 32 | 250 | 460 | 2 2 | _ |
| BCW67C | EČ | 32 | 250 250 | 630 | _ | - |
| CW61B | BB | 32 | 180 | 310 | 100 2 | 100 |

TABLE 1. General-Purpose SOT-23 Transistors (continued)

Pinout: 1-Base, 2-Emitter, 3-Collector

Devices are listed in order of descending breakdown voltage.

PNP

| | | | | hFE | | ft |
|-------------|---------|----------|-----|-----|-----------|-----------|
| Device Type | Marking | VBR(CEO) | Min | Max | @ IC (mA) | Min (MHz) |
| BCW67B | DB | 32 | 160 | 400 | 100 | 100 |
| BCW61A | BA | 32 | 120 | 220 | 2 | <u> </u> |
| BCW67A | DA | 32 | 100 | 250 | 100 | 100 |
| MMBT4125 | ZD | 30 | 60 | 80 | 50 | 200 |
| MMBB709T | ZB | 25 | 400 | 650 | 2 | – |
| MMBB709S | ZB | 25 | 290 | 460 | 2 | _ |
| BCX18 | T2 | 25 | 100 | 600 | 100 | _ |
| BCW30 | C2 | 20 | 215 | 500 | 2 | - |
| BCW29 | C1 | 20 | 120 | 260 | 2 | |

TABLE 2. SOT-23 Switching Transistors

Pinout: 1-Base, 2-Emitter, 3-Collector

NPN

| | | Switching | Time (ns) | | | pee | | f _M in (MHz) |
|------------|---------|-----------|-----------|----------------------|-----|-----|-----------|--------------------------|
| Device | Marking | TON | TOFF | V _{BR(CEO)} | Min | Max | @ IC (mA) | |
| MMBT2369 | 1J | 12 | 18 | 15 | 40 | 120 | 10 | - |
| BSX39 | 02 | 12 | 18 | 14 | 40 | 200 | 10 | |
| BSV52 | B2 | 12 | 18 | 12 | 40 | 120 | 10 | 400 |
| MMBC1621B4 | B4 | 20 | 40 | 20 | 90 | 180 | 1.0 | 200 |
| MMBC1621B3 | B3 | 20 | 40 | 20 | 60 | 120 | 1.0 | 200 |
| MMBC1621B2 | B2 | 20 | 40 | 20 | 40 | 80 | 1.0 | 20 |
| NP | | | | | | | | |
| MMBT3640 | 2.J | 25 | 35 | 12 | 30 | 120 | 10 | 500 |

TABLE 3. SOT-23 Transistors, VHF/UHF Amplifiers, Mixers, Oscillators

Pinout: 1-Base, 2-Emitter, 3-Collector

NPN

| | | f | Τ | | Cob | |
|------------|---------|-----------|-----------|----------|----------|--|
| Device | Marking | Min (GHz) | @ IC (mA) | VBR(CEO) | Max (pF) | |
| /MBT3960A | 1T | 1.600 | 30 | 8 | 2.00 | |
| MBT3960 | 15 | 1,600 | 30 | 3 | 2.00 | |
| MMBT6543 | 3F | 0.750 | 4 | 25 | 1.00 | |
| MMBTH10 | 3E | 0.650 | 4 | 25 | .70 | |
| MMBC1321Q2 | Q2 | 0.600 | 2 | 25 | 1.80 | |
| MMBC1321Q2 | Q3 | 0.600 | 2 | 25 | 1.80 | |
| WMBC1321Q4 | Q4 | 0.600 | 2 | 25 | 1.80 | |
| MMBC1321Q5 | Q5 | 0.600 | 2 | 25 | 1.80 | |
| MMBT918 | 3B | 0.600 | 4 | 15 | 1.70 | |
| MMBTH24 | 3A | 0.400 | 8 | 30 | .36 | |
| MMBC1009F1 | F1 | 0.150 | 1 | 25 | 3.50 | |
| MMBC1009F2 | F2 | 0.150 | 1 | 25 | 3.50 | |
| MMBC1009F3 | F3 | 0.150 | 1 | 25 | 3.50 | |
| MMBC1009F4 | F4 | 0.150 | 1 | 25 | 3.50 | |
| MMBC1009F5 | F5 | 0.150 | 1 | 25 | 3.50 | |

| • | |
|---|---|
| _ | - |

| FIG | | | | | |
|------------------|----|-------|----|----|------|
| MMBT4260 | 2R | 2.000 | 10 | 10 | 2.50 |
| MMBT4261 | 28 | 2.000 | 10 | 10 | 2.50 |
| MMBTH81 | 3D | 0.600 | 5 | 20 | .85 |
| I TATIANO I LIOT | - | | | | |

TABLE 4. Chopper Transistors Pinout: 1-Base, 2-Emitter, 3-Collector

PNP

| | | | | | HFE | |
|---------------------|----------|-----------------------|----------|----------|------------|-------------|
| Device | Marking | V _{BR} (EBO) | VBR(CEO) | Min | Max | @ lC (mA) |
| MMBT404 MMBT404A | 2M 2N | 12 25 | 24 35 | 30 30 | 400 400 | 12 12 |

TABLE 5. SOT-23 Darlington Transistors

Pinout: 1-Base, 2-Emitter, 3-Collector

NPN

| | | | HFE | | V | |
|--------------------------------|----------------|----------------------|-------|------------------|----------------|---------------------|
| Device | Marking | Min | Max | @ lc (mA) | VBR(CEO) | VCE(sat) Max (V) |
| MMBTA14 MMBT6427 MMBTA13 | 1N 1V 1M | 20 K 10 K 10 K | 100 K | 100 10 100 | 30 40 30 | 1.5 1.5 |
| IP | - ! | | | 100 | | 1.5 |
| MMBTA64 MMBTA63 | 2V | 10 K | | 10 | 30 | 1.5 |
| MINIO I VOS | 2U | 5.0 K | | 10 | 30 | 1.5 |

TABLE 6. Low-Noise SOT-23 Transistors

Pinout: 1-Base, 2-Emitter, 3-Collector

NPN

| | | NF dB | 1 | | | _ | |
|----------|---------|-------|----------|-----|------|------------|------------|
| Device | Marking | (Typ) | VBR(CEO) | Min | Max | @ IC (mA) | Min (MHz) |
| MMBT5088 | 1Q | 1.0 | 30 | 300 | 900 | 1.0 | 50 |
| MMBT5089 | 1R | 1.0 | 25 | 400 | 1200 | 1.0 | 50 |
| MMBT2484 | 10 | 3.0 | 60 | 100 | 600 | 0.01 | |
| MMBT6428 | 1K | 3.0 | 50 | 250 | 650 | | 15 |
| MMBT6429 | 1L | 3.0 | 45 | 500 | 1250 | 1.0 1.0 | 100 100 |
| (P | | | <u> </u> | | | | 100 |
| MMBT5087 | 2Q | 1.0 | 50 | 250 | 800 | 1.0 | 40 |
| MMBT5086 | 2P | 1.5 | 50 | 150 | 500 | 1.0 | 40 |

TABLE 7. High-Voltage SOT-23 Transistors

2L

Pinout: 1-Base, 2-Emitter, 3-Collector

NPN

| | ł | | | phE | | - |
|--------------|---------|----------|-----|-----|-----------------------|----------|
| Device | Marking | VBR(CEO) | Min | Max | @ ^I C (mA) | Min (MHz |
| MMBTA42 | 1D | 300 | 40 | | 10 | |
| MMBTA43 | 1E | 200 | 40 | i _ | 10 | 50 |
| MMBC1654N5 | N5 | 160 | 150 | 330 | 15 | 50 |
| MMBC1654N6 | N6 | 160 | 100 | 220 | 15 | 120 |
| MMBC1654N7 | N7 | 160 | 50 | 130 | | 120 |
| MMBT5550 | 1F | 150 | 60 | 250 | 15 | 120 |
| MMBC1653N2 | N2 | 130 | 150 | 330 | 10 | 100 |
| MMBC1653N3 | N3 | 130 | 100 | 220 | 15 | 120 |
| MMBC1653N4 | N4 | 130 | 50 | | 15 | 120 |
| P | | | | 130 | 15 | 120 |
| ` | | | | | | |
| MMBTA92 | 2D | 300 | 40 | _ | 10 | 50 |
| MMBTA93 | 2E | 200 | 40 | | 10 | 50 50 |

MMBT5401

100

150

240

MICROMINIATURE PRODUCTS (continued)

TABLE 8. SOT-23 Driver Transistors

Pinout: 1-Base, 2-Emitter, 3-Collector

| Device | Marking | V _{BR} (CEO) | | fτ | | |
|-----------------------------|----------------|-----------------------|----------------|------------|-----------------|------------------|
| | | | Min | Max | @ IC (mA) | Min (MHz) |
| MMBTA06 BSS64 MMBTA05 | 1G AM 1H | 80 80 60 | 50 20 50 | 80 | 10 4.0 10 | 100 50 100 |

100 вм BSS63 50 10 100 80 2G MMBTA56 10 100 50 60 2H MMBTA55

TABLE 9. RF SOT-23 Transistors

Pinout: 1-Base, 2-Emitter, 3-Collector

| IPN | | | fT | | | NF | | | Mag | | |
|----------|---------|-----------|---------|---------|----------|-----------|---------|----------|------------|--------------|------------|
| Device | Marking | Typ (GHz) | IC (mA) | VCE (V) | Typ (dB) | @ IC (mA) | VCE (V) | Typ (dB) | @ IC (mA) | VCE (V) | f (MHz) |
| | | 5.5 | 30 | 5.0 | 1.9 | 2.0 | 5.0 | 15.5 | 30 | 5.0 | 500 |
| MMBR930 | 7C | | 14 | 10 | 3.0 | 3.0 | 1.5 | - | \ - | _ | _ |
| BFR92 | P1 | 4.5 | | 10 | 3.0 | 3.0 | 1.5 | l – | _ | - | _ |
| BFR92S | P5 | 4.5 | 14 | 5.0 | 3.0 | 2.0 | 5.0 | ١ | _ | l — I | _ |
| BFR93 | R1 | 4.5 | 30 | | 3.0 | 2.0 | 5.0 | I — ' | l <u> </u> | ! — . | _ |
| BFR93S | R6 | 4.5 | 30 | 5.0 | 2.7 | 0.5 | 1.0 | 18 | 1.0 | 1.0 | 500 |
| MMBR931 | 7D | 3.5 | 1.0 | 1.0 | 2.0 | 1.5 | 10 | 13 | 20 | 10 | 500 |
| MMBR2060 | 7E | 2.5 | 20 | 10 | 4.0 | 1.5 | 6.0 | 11.0 | 5.0 | 6.0 | 450 |
| MMBR5179 | 7H | 1.5 | 5.0 | 6.0 | | 2.0 | 10 | 17 | 14 | 10 | 1000 |
| MMBR920 | 7B | 5.0 | 14 | 10 | 2.4 | 5.0 | 6.0 | 10.5 | 15 | 10 | 1000 |
| MMBR901 | 7A | 4.0 | 15 | 10 | 2.3 | | 6.0 | 13.5 | 5.0 | 6.0 | 450 |
| MMBR5031 | 7G | 2.0 | 5.0 | 6.0 | 1.9 | 1.0 | 0.0 | 13.5 | 3.0 | - | _ |
| MMBR2857 | 7K | 1.0 | 4.0 | 10 | I = | 1 == | - | - | 1 - | _ | 30 |
| BFS17 | E1 | 1.0 | 2.0 | 5.0 | 5.0 | 2.0 | 5.0 | 1 - | - | | 30 |
| BFS17S | E5 | 1.0 | 2.0 | 5.0 | 5.0 | 2.0 | 5.0 | | | <u> </u> | |
| NP | | | _ | | | | | , | | 1 | 1 |
| MMBR4957 | 7F | 2.0 | 2.0 | 10 | 2.5 | 2.0 | 10 | 14.5 | 2.0 | 10 | 450 |

TABLE 10. RF Junction Field-Effect SOT-23 Transistors

Pinout: 1-Base, 2-Emitter, 3-Collector

N_CHANNEL

| N-CHAMILE | | | F | |] | | |
|----------------------|---------|----------|---------|-------------|-------------|---------------------|----------|
| Device | Marking | Typ (dB) | f (MHz) | Min (mmhos) | Max (mmhos) | V _{DS} (V) | V(BR)GSS |
| | 6C | 1,5 | 100 | 10 | 18 | 10 | - 25 |
| MMBFU310 | 6B | 2.0 | 100 | 3.0 | 6.0 | 15 | -25 |
| MMBF5484 | 6H | 2.0 | 100 | 4.0 | 8.0 | 15 | -25 |
| MMBF5486 MMBF4416 | 6A | 2.0 | 100 | 4.5 | 7.5 | 15 | -30 |
| MMBF4410 | 6T | 4.0 | 450 | 8.0 | 18 | 10 | - 25 |

TABLE 11. General-Purpose Field-Effect SOT-23 Transistors

Pinout: 1-Base, 2-Emitter, 3-Collector

N-CHANNEL

| | | | | Yfs | | ^I DSS | | |
|--|----------------------|----------------------|--------------------------|--------------------------|----------------------|--------------------------|------------------------|--|
| Device | Marking | V(BR)GSS | Min (mmhos) | Max (mmhos) | VDS (V) | Min (mA) | Max (mA) | |
| MMBF5457 BFR30 BFR31 MMBF5459 | 6D M1 M2 6L | 25 25 25 25 | 1.0 1.0 1.5 2.0 | 5.0 4.0 4.5 6.0 | 15 10 10 15 | 1.0 4.0 1.0 4.0 | 5.0 10 5.0 16 | |
| -CHANNEL | | | | | | | | |
| MMBF5460 | 6E | 40 | 1.0 | 4.0 | 15 | 1.0 | 5.0 | |

TABLE 12. Chopper/Switches, Junction Field-Effect SOT-23 Transistors

N-CHANNEL

| | | rDS(on) | toff | | V _{(G} | S) off | l _D | ss |
|--|----------------------|-----------------------|----------------------|--------------------------|------------------------------|-----------------------------|-----------------------|------------------------|
| Device | Marking | Max (Ohms) | Max (ns) | V(BR)GSS | Min (V) | Max (V) | Min (mA) | Max (mA) |
| MMBF4391 MMBF4860 MMBF4392 MMBF4393 | 6J 6F 6K 6G | 30 40 60 100 | 20 50 35 55 | -30 -30 -30 -30 | -4.0 -2.0 -2.0 -0.5 | -10 -6.0 -5.0 -3.0 | 50 20 25 5.0 | 150 100 75 30 |

TABLE 13. SOT-23 Switching Diodes (Dual Unless Otherwise Noted)

Diode Pinout: Noted Below

| | } | 1 | | t _{rr} Max | \ \u | lR | l | ٧F | | |
|------------------|----------------|---|-----|------------------------|----------------------------|-------------|-------------|---------|-----------|-----------------|
| Device | Marking | Description | | (ns) | V _{BR} Min (V) | Max (μA) | Min (V) | Max (V) | @ lF (mA) | CVR Max (pF) |
| MMBD2836 | A2 | Common Anode | (5) | 6(1) | 75 | 0.1 | | 1.0 | 10 | |
| BAW56 | A1 | Common Anode | (5) | 6(1) | 70 | 2.5 | l _ | 1.1 | 50 | 4.0 |
| MMBD2835 | A3 | Common Anode | (5) | 6(1) | 35 | 0.1 | 1 = | 1.0 | | 1.5 |
| BAV74 | Í JA | Common Cathode | (3) | 2(2) | 50 | 0.1 | | | 10 | 4.0 |
| MMBD2838 | A6 | Common Cathode | (3) | 6(1) | 75 | 0.1 | Į. | 1.0 | 100 | 2.0 |
| BAV70 |) A4 | Common Cathode | (3) | 6(1) | 70 | 2.5 | — | 1.0 | 10 | 4.0 |
| MMBD2837 | A5 | Common Cathode | (3) | 6(1) | 35 | 2.5 0.1 | _ | 1.1 | 50 | 1.5 |
| MMBD6100 | 5B | Common Cathode | (3) | 15(1) | 70 | | | 1.0 | 10 | 4.0 |
| MMBD914 | 5D | Single | (6) | 4(2) | | 0.1 | 0.85 | 1.1 | 100 | 2.5 |
| BAS16 | A6 | Single | | | 100 | 0.05 | - | 1.0 | 10 | 4.0 |
| BAL99 | TF | Single | (6) | 6(1) | 75 | 1.0 | ı – | 0.715 | 1.0 | 2.0 |
| MMBD6050 | 5A | Single | (7) | 6(1) | 70 | 2.5 | _ | 1.1 | 50 | 1.5 |
| 3AV99 | A7 | Series | (6) | 10(1) | 70 | 0.1 | 0.85 | 1.1 | 100 | 2.5 |
| MBD7000 | SC SC | | (4) | 6(1) | 70 | 2.5 | - | 1.1 | 50 | 1.5 |
| | | Series | (4) | 15(1) | 100 | 0.3 | 0.75 | 1.1 | 100 | 1.5 |
| OTES: (1) IF = I | a = 10 mA, VR | = 5.0 V, IRR = 1.0 mA | | | | | | | | |
| (2) IF = I | 7 = 10 mA, VR | = 6.0 V, IRR = 1.0 mA | | | | | | | | |
| (3) Pinout: | 1-Anode, 2-Ano | ode, 3-Cathode | | | | | | | | |
| (4) Pinout: | 1-Anoge, 2-Cat | hode, 3-Cathode and Anocathode, 3-Anode | te | | | | | | | |

⁽⁶⁾ Pinout: 1-Anode, 2-N.C., 3-Cathode (7) Pinout: 1-N.C., 2-Anode, 3-Cathode

TABLE 14. SOT-23 Tuning Diodes
Tuning Diode Pinouts: 1-Anode, 2-N.C., 3-Cathode

| | | B\ | /B | | Ст | | Capac Ra | | | Q | | Rs | v | F | l ₁ | R |
|----------------|---------|------------|--------------|-------------|-------------|-------------------------|-------------|----------|----------|-------------------------|--------------|---------------|------------|------------|----------------|-------------------------|
| Device | Marking | Min (V) | @ IR (μA) | Min (pF) | Max (pF) | @ V _R (V) | Min | Max | Min | @ V _R (V) | & f (MHz) | Max (ohms) | Max (V) | @ lp | Max (μA) | @ V _R (V) |
| TUNING DIODI | ES | | | | | | | | | | | | | | | · |
| MMBV2097 | 4K | | 10 | .8 | 1.2 | 4 | 2 | 2.6 | 325 | 4 | 100 | _ | _ | _ | .02 | 25 |
| MMBV2098 | 4L | 30 | 10 | 1.8 | 2.7 | | | 2.8 | | | | | | L | | |
| MMBV105G | 4E | | | 1.8 | 2.8 | 2.5 | 4 | 6 | 150 | (1) | 100 | - 1 | _ | | .05 | 28 |
| MMBV2101 | 4G | 30 | 10 | 6.1 | 7.5 | 4 | 2.5 | 3.3 | 450 | 4 | 50 | | | | .02 | 25 |
| MMBV2103 | 4H | | | 9.0 | 11 | | 2.6 | 0.0 | 400 | <u> </u> | | | | <u> </u> | | |
| MMBV3102 | 4C | 30 | 10 | 20 | 25 | 3 | 4.5 | | 300 | 3 | 50 | <u> </u> | _ | <u> </u> | .1 | 25 |
| MMBV2108 | 4X | 30 | 10 | 24.3 | 29.7 | 4 | 2.7 | 3.3 | 300 | 4 | 50 | <u> </u> | <u> </u> | <u> </u> | .02 | 25 |
| MMBV109 | 4A | 30 | 10 | 26 | 32 | .3 | 5 | 6.5 | 280 | 3 | 50 | <u> </u> | | ļ <u> </u> | .02 | 25 |
| MMBV2109 | 41 | 30 | 10 | 29.7 | 36.3 | 4 | 2.7 | 3.3 | 200 | 4 | 50 | <u> </u> | <u> </u> | <u> </u> | .02 | 25 |
| "PIN" CHANN | EL SWI | TCH | | | | | | | | | | | | | | , . |
| MMBV3401 | 4D | 35 | 10 | Γ- | 1 | 20 | <u> </u> | <u> </u> | <u> </u> | <u> </u> | <u> </u> | .7 | | | .1_ | 25 |
| HOT CARRIES | DIODE | S | | | | | | | | | | | | | | |
| MMBD101 | 4M | 4 | 10 | 1 - | | | T - | T = | | | <u> </u> | | .6 | _ | .25 | 3 |
| MMBD352 (Dual) | + | 4 | .25 | T- | 1 | 0 | _ | T - | _ | | | | .50 | 10 | | — |
| MMBD501 | 5F | 50 | 10 | T = | 1 | 20 | Τ- | Τ- | T - | _ | _ | | 1.2 | | .2 | 25 |

Notes: (1) Voltage such that CT = 9.0 pF.

TABLE 15. SOT-23 Zener Diodes

Pinout 1-Anode, 2-N.C., 3-Cathode (Tolerance ± 5%)

| VZ (Nom) Volts | U.S. Standards | Device Marking | Pro-Electron Equivalent | Device Marking |
|-------------------|-------------------|-------------------|----------------------------|-------------------|
| 3.3 | MMBZ5226 | 8A | | |
| 3.6 | MMBZ5227 | 8B | 1 | |
| 3.9 | MMBZ5228 | 8C | 1 | |
| 4.3 | MMBZ5229 | 8D | | Z 1 |
| 4.7 | MMBZ5230 | 8E | BZX84C4V7 | Z1 Z2 |
| 5.1 | MMBZ5231 | 8F | BZX84C5V1 | 22 23 |
| 5.6 | MMBZ5232 | 8G | BZX84C5V6 | 23 |
| 6.0 | MMBZ5233 | 8H | | 74 |
| 6.2 | MMBZ5234 | 8J | BZX84C6V2 | Z4 |
| 6.8 | MMBZ5235 | 8K | BZX84C6V8 | Z 5 |
| 7.5 | MMBZ5236 | 8L | BZX84C7V5 | <u>Z6</u> |
| 8.2 | MMBZ5237 | 8M | BZX84C8V2 | Z7 |
| 8.7 | MMBZ5238 | 8N | 1 ! | |
| 9.1 | MMBZ5239 | 8P | BZX84C9V1 | ZB |
| 10.0 | MMBZ5240 | 8Q | BZX84C10 | Z9 |
| 11.0 | MMBZ5241 | 8R | BZX84C11 | Y1 |
| 12.0 | MMBZ5242 | 8S | BZX84C12 | Y2 |
| 13.0 | MMBZ5243 | 8T | BZX84C13 | Y3 |
| 14.0 | MMBZ5244 | 8U | 1 1 | |
| 15.0 | MMBZ5245 | 8V | BZX84C15 | Y4 |
| 16.0 | MMBZ5246 | 8W | BZX84C16 | Y5 |
| 17.0 | MMBZ5247 | 8X | | |
| 18.0 | MMBZ5248 | 8Y | BZX84C18 | Y6 |
| 19.0 | MMBZ5249 | 8Z | | |
| 20.0 | MMBZ5250 | 81A | BZX84C20 | Y7 |
| 20.0 22.0 | MMBZ5251 | 81B | BZX84C22 | Y8 |
| 22.0 24.0 | MMBZ5252 | 81C | BZX84C24 | Y9 |

TABLE 15. SOT-23 Zener Diodes (continued)

Pinout 1-Anode, 2-N.C., 3-Cathode (Tolerance ± 5%)

| VZ (Nom) Volts | U.S. Standards | Device Marking | Pro-Electron Equivalent | Device Marking |
|-------------------|-------------------|-------------------|----------------------------|-------------------|
| 25.0 | MMBZ5253 | 81D | | |
| 27.0 | MMBZ5254 | 81E | BZX84C27 | Y10 |
| 28.0 | MMBZ5255 | 81F | 1 | |
| 30.0 | MMBZ5256 | 81G | BZX84C30 | Y11 |
| 33.0 | MMBZ5257 | 81H | BZX84C33 | Y12 |

TABLE 16. SOT-23 Silicon Controlled Rectifier

Rectifier Pinouts: 1-Cathode, 2-Gate, 3-Anode

| Device | Marking | IF (mA) | V _{FXM} (mA) | lgT (μA) | V _{GT} (V) | l _H (mA) |
|----------|---------|---------|-----------------------|----------|---------------------|---------------------|
| MMBS5062 | 5T | 500 | 100 | 200 | .8 | 5 |
| MMBS5061 | 5S | 500 | 50 | 200 | .8 | 5 |
| MMBS5060 | 5R | 500 | 25 | 200 | .8 | 5 |

TABLE 17. SOT-23 Silicon Programmable Unijunction Transistors

Transistor Pinouts: 1-Cathode, 2-Gate, 3-Anode

| Device | Marking | ITRM (Amp) (1) | ITSM (Amp) (2) | Max (μA) Ip (3) | Min (V) V _T | Max (V) | Max (μA) Iy (3) | Max (V) VF |
|----------|---------|----------------|----------------|-----------------|------------------------|---------|-----------------|------------|
| MMBPU131 | 5Z | 1 | 1 | 2 | .2 | .7 | 50 | 1.5 |

NOTES:

 Repetitive Peak Forward Current 100 μs Pulse Width

1.0% Duty Cycle

2. Non-Repetitive Peak Forward Current

10 μs Pulse Width

3. Vs = 10 Vdc, Rg = 1.0 m Ω

TABLE 18. SOT-89 Transistors

Pinout: 1-Base, 2-Collector, 3-Emitter

General Purpose

NPN

| | i L | | | _ ا | |
|---------|----------|-----|-----|-----------|-----------|
| Device | VBR(CEO) | Min | Max | @ IC (mA) | Min (MHz) |
| BCX56 | 80 | 40 | 160 | 150 | 50 |
| BCX55 | 60 | 40 | 160 | 150 | 50 |
| BCX54 | 45 | 40 | 250 | 150 | 50 |
| MXT3904 | 40 | 100 | 300 | 10 | 300 |
| BCX68 | 20 | 85 | 375 | 500 | 65 |

| BCX53 80 40 BCX52 60 40 BCX51 45 40 MX73908 40 100 BCX69 20 85 | 160 150 160 150 250 150 300 10 375 500 | 50 50 50 250 65 |
|--|--|-----------------------------|
|--|--|-----------------------------|

TABLE 18. SOT-89 Transistors (continued) Pinout: 1-Base, 2-Collector, 3-Emitter

High Voltage

| M | 0 | м |
|----|---|---|
| 17 | г | N |

| MXTA44 MXTA42 MXTA43 | 400 300 200 | 50 40 50 | 200 — 200 | 10 10 30 | 50 — |
|----------------------------|-------------------|----------------|-----------------|----------------|---------------------------------------|
| PNP | | | T | | · · · · · · · · · · · · · · · · · · · |
| MXTA92 MXTA93 | 300 200 | 40 30 | 150 | 10 30 | 50 50 |

Darlingtons

| | hFE | | | | V _{CE(sat)} | |
|--------|------|-----|-----------|----------------------|----------------------|--|
| Device | Min | Max | @ IC (mA) | V _{BR(CBO)} | VCE(sat) Max (V) | |
| N | | | | | | |
| MXTA27 | 10 K | _ | 10 | 60 | 1.5 | |
| MXTA14 | 10 K | | 10 | 30 | 1.5 | |
| IP | • | | | | | |
| MXTA77 | 10 K | _ | 10 | 60 | 1.5 | |

RF

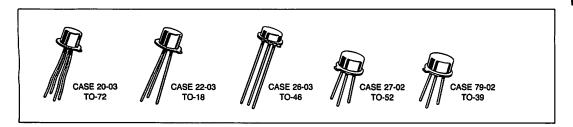
NPN

| fr | | | hFE | | |
|-----------|-------------------------------|---|---|---|---|
| Min (MHz) | I _C (mA) | VBR(CEO) | Min | Max | Ic (mA) |
| 4000 | | 15 | 25 | _ | 50 |
| | | 1 | 25 | l <u> </u> | 50 |
| | | | 25 | 300 | 50 |
| | | | | _ | 50 |
| 500 | 50 | 30 | 10 | 200 | 50 |
| | 4000 3200° 1200 1200 | 4000 50 3200° — 1200 50 1200 150 | 4000 50 15 3200° — 15 1200 50 30 1200 150 25 | 4000 50 15 25 3200° — 15 25 1200 50 30 25 1200 150 25 25 | Min (MHz) I _C (mA) VBR(CEO) Min Max 4000 50 15 25 — 3200° — 15 25 — 1200 50 30 25 300 1200 150 25 25 — |

| PNP | | | | , | | |
|---------|------|----|----|----|-----|-----|
| MXR5583 | 1000 | 40 | 30 | 25 | 100 | 100 |
| MXR5160 | 500 | 50 | 40 | 10 | | 50 |

тур

Metal Small-Signal Transistors



Motorola Small-Signal Metal Can Transistors are designed for use as General-Purpose Amplifiers, High-Speed Switches, High-Voltage Amplifiers, Low-Level/Low-Noise Amplifiers, High-Frequency Oscillators, Choppers, and Darlingtons. These devices are manufactured in a variety of packages, i.e., TO-18, TO-39,

TO-46, TO-52, and TO-72.

The following selector guide tables also indicate those Motorola small-signal metal can transistors which are qualified to MIL-19500 high-rel requirements. Devices are available in the JAN, JANTX, JANTXV and JANS versions as specified.

TABLE 1. Switching Transistors

The following devices are intended for use in general-purpose switching and amplifier applications. Within each package group shown, the devices are listed in order of decreasing turn-on time (t_{on}) .

| Package | Device Type | t _{on} ns (Max | toff k ns (Max | @ IC mA | V _(BR) CEO Volts Min | IC mA Max | hpe (| @ IC mA | VCE(sat) Volts Max | @ IC @ mA | ⊕ lg mA | fT MHz MIn | IC mA |
|-------------|----------------|--------------------------------|-------------------------|--------------|---------------------------------------|-----------------|-------|--------------|--------------------------|----------------|--------------|------------------|----------|
| IPN | | | | | | | | | | | | | |
| TO-18 | 2N2540 | 40 | 40 | 150 | 30 | | 100 | 150 | 0.45 | 150 | 15 | 250 | 20 |
| | 2N914** | 40 | 40 | 200 | 15 | 150 | 12 | 10 | 0.7 | 200 | 20 | 300 | 20 |
| | 2N4014 | 35 | 60 | 500 | 50 | 1000 | 35 | 500 | 0.52 | 500 | 50 | 300 | 50 |
| | 2N4013 | 35 | 60 | 500 | 30 | 1000 | 35 | 500 | 0.42 | 500 | 50 | 300 | 50 |
| | 2N2501 | 15 | 25 | 300 | 20 | l | 10 | 500 | 0.3 | 50 | 5.0 | 350 | 10 |
| | 2N2369 | 12 | 18 | 100 | 15 | 500 | 20 | 100 | 0.25 | 10 | 1.0 | 500 | 10 |
| | 2N2369A† | 12 | 18 | 10 | 15 | 200 | 40 | 10 | 0.2 | 10 | 1.0 | 500 | 10 |
| | 2N3227 | 12 | 18 | 100 | 20 | 50 | 30 | 100 | 0.25 | 10 | 1.0 | 500 | 10 |
| TO-39 | 2N3444** | 50 | 70 | 500 | 50 | | 20 | 500 | 0.6 | 500 | 50 | 175 | 50 |
| | 2N3253** | 50 | 70 | 500 | 40 | | 25 | 500 | 0.6 | 500 | 50 | 175 | 50 |
| | 2N3735# | 48 | 60 | 1000 | 50 | 1500 | 20 | 1000 | 0.5 | 500 | 50 | 250 | 50 |
| | 2N3734 | 48 | 60 | 1000 | 50 | 1500 | 30 | 1000 | 0.5 | 500 | 50 | 250 | 50 |
| | 2N3252 | 45 | 70 | 500 | 30 | | 30 | 500 | 0.5 | 500 | 50 | 200 | 50 |
| | 2N3506# | 45 | 90 | 1500 | 40 | 3000 | 40 | 1500 | 1.0 | 1500 | 150 | 60 | 100 |
| | 2N3507# | 45 | 90 | 1500 | 50 | 3000 | 30 | 1500 | 1.0 | 1500 | 150 | 60 | 100 |
| | 2N3725 | 35 | 60 | 500 | 50 | 2000 | 35 | 500 | 0.52 | 500 | 50 | 300 | 50 |
| | 2N3725A | 35 | 60 | 500 | 30 | 1200 | 35 | 500 | 0.52 | 500 | 50 | 300 | 50 |
| | 2N3724 | 35 | 60 | 500 | 30 | 2000 | 35 | 500 | 0.42 | 500 | 50 | 300 | 50 |
| | 2N3724A | 35 | 60 | 500 | 30 | 1200 | 35 | 500 | 0.42 | 500 | 50 | 300 | 50 |
| | MM5262 | 30 | 60 | 1000 | 50 | 2000 | 25 | 1000 | 0.8 | 1000 | 100 | 350(typ) | 50 |
| | 2N5861 | 25 | 60 | 500 | 50 | 2000 | 25 | 500 | 0.5 | 500 | 50 | 200 | 50 |
| | 2N3303 | 15 | 25 | 1000 | | 1000 | 20 | 10 | 0.7 | 1000 | 100 | 450 | 100 |
| TO-46 | 2N3736 | 48 | 60 | 1000 | 30 | 1500 | 30 | 1000 | 0.5 | 500 | 50 | 250 | 50 |
| | 2N3737# | 48 | 60 | 1000 | 50 | 1500 | 20 | 1000 | 0.5 | 500 | 50 | 250 | 50 |
| | 2N3647 | 20 | 25 | 150 | . 10 | 500 | 25 | 150 | 0.4 | 150 | 15 | 350 | 15 |
| | 2N3648 | 16 | 18 | 150 | 15 | 500 | 30 | 150 | 0.4 | 150 | 15 | 450 | 15 |
| | 2N3508 | 12 | 18 | 10 | 20 | 500 | 40 | 10 | 0.25 | 10 | 1.0 | 500 | 10 |
| | 2N3509 | 12 | 18 | 10 | 20 | 500 | 100 | 10 | 0.25 | 10 | 1.0 | 500 | 10 |
| TO-52 | MM1748 | 6.0 | 15 | 10 | _ | 150 | 20 | 10 | _ | | _ | 600 | 5.0 |
| | MM1748A | 10 | 15 | 10 | 1 | 150 | 20 | 10 | _ | _ | _ | 600 | 5.0 |
| NP | | | | | | | | | | | | | |
| TO-18 | 2N2894 | 60 | 90 | 30 | 12 | 200 | 40 | 30 | 0.2 | 30 | 3.0 | 400 | 30 |
| | 2N869A** | 50 | 80 | 30 | 18 | 200 | 40 | 30 | 0.2 | 30 | 3.0 | 400 | 10 |
| | 2N3546 | 40 | 30 | 50 | 12 | | 25 | 50 | 0.25 | 50 | 5.0 | 700 | 10 |
| | 2N4208 | 15 | 20 | 10 | 12 | 200 | 30 | 10 | 0.15 | 10 | 1.0 | 700 | 10 |
| | MM4258 | 15 | 20 | 10 | 12 | 80 | 30 | 10 | 0.15 | iŏ | 1.0 | 700 | 10 |
| | 2N4209 | 15 | 20 | 10 | 15 | 50 | 40 | 50 | 0.6 | 50 | 5.0 | 850 | 10 |
| N available | "JAN/JAN | X availabl | e †J/ | XT/JANTX | /JANTXV/JANS | available | #3 | AN/JANT | X/JANTXV avail | able | _==- | | |

SMALL-SIGNAL DEVICES

TABLE 1. Switching Transistors (continued)

| Package | Device Type | ton ns & Max | toff k ns @ Max | IC mA | V(BR)CEO Voits Min | IC mA Max | hFE @ | IC mA | VCE(sat) Volts (Max | P IC @ | l _B | f _T MHz Min | IC mA |
|---------|----------------|--------------------|-------------------------|----------|--------------------------|-----------------|-------|----------|----------------------------|--------|----------------|------------------------------|----------|
| NP | | | | | | | | | | | | | |
| TO-39 | 2N3634# | 400 | 600 | 50 | 140 | 1000 | 50 | 50 | 0.5 | 50 | 5.0 | 150 | 30 |
| | 2N3635# | 400 | 600 | 50 | 140 | 1000 | 100 | 50 | 0.5 | 50 | 5.0 | 200 | 30 |
| | 2N3636# | 400 | 600 | 50 | 175 | 1000 | 50 | 50 | 0.5 | 50 | 5.0 | 150 | 30 |
| | 2N4036 | 110 | 700 | 150 | 65 | 1000 | 40 | 150 | 0.65 | 150 | 15 | 60 | 50 |
| | 2N4030 | 100 | 240(typ) | 500 | 60 | 1000 | 15 | 1000 | 1.0 | 1000 | 100 | 100 | 50 |
| | 2N4031 | 100 | 240(typ) | 500 | 80 | 1000 | 10 | 1000 | 0.5 | 500 | 50 | 100 | 50 |
| | 2N4032 | 100 | 240(typ) | 500 | 60 | 1000 | 40 | 1000 | 1.0 | 1000 | 100 | 150 | 50 |
| | 2N4033# | 100 | 240(typ) | 500 | 80 | 1000 | 25 | 1000 | 0.5 | 500 | 50 | 150 | 50 |
| | 2N4406 | 75 | 225 | 1000 | 80 | 1500 | 20 | 1000 | 0.7 | 1000 | 100 | 150 | 50 |
| | 2N4407 | 75 | 225 | 1000 | 80 | 1500 | 30 | 1000 | 0.7 | 1000 | 100 | 150 | 50 |
| | 2N3245 | 55 | 165 | 500 | 50 | 1000 | 30 | 500 | 0.6 | 500 | 50 | 150 | 50 |
| | 2N3244 | 50 | 185 | 500 | 40 | 1000 | 50 | 500 | 0.5 | 500 | 50 | 175 | 50 |
| | 2N3467# | 40 | 90 | 500 | 40 | 100 | 40 | 500 | 0.5 | 500 | 50 | 175 | 50 |
| | 2N3468# | 40 | 90 | 500 | 50 | 1000 | 25 | 500 | 0.6 | 500 | 50 | 150 | 50 |
| | 2N3762# | 43 | 115 | 1000 | 40 | 1500 | 30 | 1000 | 0.9 | 1000 | 100 | 180 | 50 |
| | 2N3763# | 43 | 115 | 1000 | 60 | 1500 | 20 | 1000 | 0.9 | 1000 | 100 | 150 | 50 |
| | 2N4404 | 40 | 210 | 500 | 80 | 1000 | 30 | 500 | 0.5 | 500 | 50 | 200 | 50 |
| | 2N4405** | 40 | 210 | 500 | 80 | 1000 | 50 | 500 | 0.5 | 500 | 50 | 200 | 50 |
| | 2N5022 | 40 | 90 | 500 | _ | 500 | 25 | 1000 | 0.8 | 1000 | 100 | 170 | 50 |
| | 2N5023 | 40 | 90 | 500 | l – | 500 | 40 | 1000 | 0.7 | 1000 | 100 | 200 | 50 |

^{*}JAN available

†JAN/JANTX/JANTXV/JANS available

#JAN/JANTX/JANTXV available

TABLE 2. High-Gain Low-Noise Transistors

These transistors are characterized for high-gain and low-noise applications. Devices are listed in decreasing order of NF.

| Package | Device Type | NF Wideband Typ* Max dB | V(BR)CEO Volts Min | IC mA Max | h _i Min | FE (| lC μΑ | f† MHz (Min | lc mA |
|-----------|----------------|----------------------------------|--------------------------|-----------------|-----------------------|------|----------|--------------------|----------|
| NPN | | | | | | | | | |
| TO-18 | 2N2484# | 8.0* | 60 | 50 | 100 | 500 | 10 | 15 | 0.05 |
| 10.0 | 2N930A | 3.0 | 45 | 30 | 100 | 300 | 10 | 45 | 0.5 |
| | 2N930** | 3.0 | 45 | 30 | 100 | 300 | 10 | 30 | 0.5 |
| IPN DARLI | NGTON | | | | | | | | |
| TO-18 | MM6427 | | 40 | 300 | 5000 | | 10° | 125 | 100 |
| PNP | | | | | | | | | ··· |
| TO-18 | 2N3962 | 10 | 60 | 200 | 100 | 450 | 1.0 | 40 | 0.5 |
| 10-10 | 2N3963 | 10 | 80 | 200 | 100 | 450 | 1.0 | 40 | 0.5 |
| | 2N3965 | 8.0 | 60 | 200 | 250 | 600 | 1.0 | 50 | 0.5 |
| | 2N3964 | 4.0 | 45 | 200 | 250 | 600 | 1.0 | 50 | 0.5 |
| | 2N3798 | 3.5 | 60 | 50 | 150 | 450 | 500 | 30 | 0.5 |
| | 2N3799 | 2.5 | 60 | 50 | 300 | 900 | 500 | 30 | 0.5 |
| TO-46 | 2N2604 | 4.0 | 45 | 0 | 40 | 120 | 0.01 | 30 | 0.5 |
| 1040 | 2N2605# | 4.0 | 45 | 30 | 100 | 300 | 0.01 | 30 | 0.5 |

[&]quot;JAN/JANTX available

TABLE 3. High-Frequency Amplifiers/Oscillators

The transistors shown are designed for use as both oscillators and amplifiers at UHF and VHF frequencies. Devices are listed in decreasing order of V(BR)CEO with each line.

| Package | Device Type | V(BR)CEO Volts Min | hFE (| @ IC mA | G _{pe} dB Min | NF dB (Max | @ f MHz | fT MHz @ Min | P IC mA | C _{obo} pF Max |
|---------|----------------|--------------------------|-------|--------------|------------------------------|-------------------|--------------|--------------------|---------|-------------------------------|
| (PN | | | | | | | | | | • |
| TO-18 | MM1941 | 20 | 25 | 10 | 7.0 | _ | _ | 600 | 10 | 2.5 |
| TO-72 | 2N918† | 15 | 20 | 3.0 | 15 | 6.0 | 60 | 600 | 4.0 | 1.7 |
| NP | | | | | | | | | | |
| TO-18 | 2N3307 | 35 | 40 | 2.0 | 17 | 4.5 | 200 | 300 | 2.0 | 1.3 |
| TO-72 | 2N4261# | 15 | 30 | 10 | _ | _ | | 1600 | 10 | 2.5 |
| | 2N4260 | 15 | 30 | 10 | _ | | _ | 2000 | 10 | 2.5 |

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The following table lists Motorola standard devices that have high Collector-Emitter Breakdown Voltage. Devices are listed in decreasing order of V(BR)CEO within each package type.

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| | Device | V(BR)CEO Volts | IC mA | hpe (| @ lc | VCE (sat) Volts | @ lc | & lg | f† MHz (| @ lc |
|---------|---------|-------------------|----------|-------|------|--------------------|------|------|-------------|----------|
| Package | Туре | Min | Max | Min | mA | Max | mA | mA | Min | i mA |
| 'n | | | · | | · | | 1 | | ! | |
| TO-18 | 2N6431 | 300 | 50 | 50 | 30 | 0.5 | 20 | 2.0 | 50 | 10 |
| | 2N6430 | 200 | 50 | 50 | 30 | 0.5 | 20 | 2.0 | 50 | 10 |
| TO-39 | MM8520 | 500 | 1000 | 15 | 10 | 1.5 | 10 | 2.0 | 5.0 | 10 |
| | 2N3439# | 350 | 1000 | 40 | 20 | 0.5 | 50 | 4 | 15 | 10 |
| | MM421 | 325 | 1000 | 25 | 30 | 5.0 | 30 | j 3 | 15 | 10 |
| | 2N3742 | 300 | 50 | 20 | 30 | 1.0 | 30 | 3.0 | 30 | 10 |
| | 2N5058 | 300 | 150 | 35 | 30 | 1.0 | 30 | 3.0 | 30 | 10 |
| | MM420 | 250 | 1000 | 25 | 30 | 5.0 | 30 | 3 | 15 | 10 |
| | 2N3440# | 250 | 1000 | 40 | 20 | 0.5 | 50 | 4 | 15 | 10 |
| | MM3003 | 250 | 50 | 20 | 10 | | ** | 1 | 150 | 10 |
| | 2N4927 | 250 | 50 | 20 | 30 | 2.0 | 30 | 3.0 | 30 | 10 |
| | 2N5059 | 250 | 150 | 30 | 30 | 1.0 | 30 | 3.0 | 30 | 10 |
| | MM3002 | 200 | 50 | 20 | 10 | | 1 33 | 5.5 | 150 | 10 |
| | 2N4926 | 200 | 50 | 20 | 30 | 2.0 | 30 | 3.0 | 30 | 10 |
| | MM3009 | 180 | 400 | 40 | 10 | | " | 5.5 | 50 | 20 |
| | MM3001 | 150 | 200 | 20 | 10 | | | | 150 | 10 |
| | 2N3114 | 150 | 200 | 30 | 30 | 1.0 | 50 | 5.0 | 40 | 30 |
| | 2N3500# | 150 | 300 | 40 | 150 | 0.4 | 150 | 15 | 150 | 20 |
| | 2N350# | 150 | 300 | 100 | 150 | 0.4 | 150 | 15 | 150 | 20 |
| | 2N3712 | 150 | 200 | 30 | 30 | 2.0 | 50 | 5.0 | 40 | 30 |
| | 2N5682 | 120 | 1000 | 40 | 250 | 0.6 | 250 | 25 | 30 | 100 |
| | MM3008 | 120 | 400 | 40 | 10 | 0.0 | -30 | 2.5 | 50 | 20 |
| | 2N657 | 100 | , ,,, | 30 | 200 | 4.0 | 200 | 40 | 30 | 20 |
| | 2N3498# | 100 | 500 | 40 | 150 | 0.6 | 300 | 30 | 150 | 20 |
| | 2N3499# | 100 | 500 | 100 | 150 | 0.6 | 300 | 30 | 150 | 20 |
| | 2N4924 | 100 | 200 | 40 | 150 | 0.4 | 50 | 5.0 | 100 | 20 |
| | MM3007 | 100 | 2500 | 50 | 250 | 0.35 | 150 | 15 | 50 | 50 50 |
| | 2N5681 | 100 | 1000 | 40 | 250 | 0.6 | 250 | 25 | 30 | 100 |
| | MM3006 | 80 | 2500 | 50 | 200 | 0.35 | 150 | 15 | 50 | 50 |
| | 2N4239 | 80 | 3000 | 30 | 250 | 0.3 | 500 | 50 | 2 | 100 |
| | MM3005 | 60 | 2500 | 50 | 150 | 0.35 | 150 | 15 | 50 | 50 |
| | 2N656 | 60 | | 30 | 200 | 4.0 | 200 | 40 | 30 | 30 |
| | 2N4238 | 60 | 3000 | 30 | 250 | 0.3 | 500 | 50 | 2 | 100 |
| | 2N4237 | 40 | 3000 | 30 | 250 | 0.3 | 500 | 50 | 2 | 100 |

TABLE 4. High-Voltage/High-Current Amplifiers

TABLE 4. High-Voltage High-Current Amplifiers (continued)

| Package | Device Type | V(BR)CEO Volts Min | IC mA Max | hFE @ | P IC mA | VCE (sat) Volts @ Max | lc 8 | lB mA | fy MHz @ Min | lc mA |
|---------|----------------|--------------------------|-----------------|-------|---------|-----------------------------|------|----------|--------------------|----------|
| NP | | | | | | | | | | |
| TO-18 | 2N6433 | 300 | 1000 | 30 | 30 | 0.5 | 20 | 2.0 | 50 | 10 |
| | 2N6432 | 200 | 1000 | 30 | 30 | 0.5 | 20 | 2.0 | 50 | 10 |
| | 2N3497 | 120 | 100 | 40 | 10 | 0.35 | 10 | 1.0 | 150 | 20 |
| | 2N3496 | 80 | 100 | 40 | 10 | 0.3 | 10 | 1.0 | 200 | 20 |
| TO-39 | 2N3743# | 300 | 50 | 25 | 30 | 8.0 | 30 | 3.0 | 30 | 10 |
| | ●2N5416# | 300 | 1000 | 30 | 50 | 2.5 | 50 | 5 | 15 | 10 |
| | MM4003 | 250 | 500 | 20 | 10 | 5.0 | 10 | 1.0 | - 1 | _ |
| | 2N4931# | 250 | 500 | 20 | 20 | 5.0 | 10 | 1.0 | 20 | 20 |
| | MM4002 | 200 | 500 | 20 | 10 | 5.0 | 10 | 1.0 | _ | _ |
| | 2N4930# | 200 | 500 | 20 | 20 | 5.0 | 10 | 1.0 | 20 | 20 |
| | e2N5415# | 200 | 1000 | 30 | 50 | 2.5 | 50 | 5 | 15 | 10 |
| | 2N3637# | 175 | 1000 | 100 | 50 | 0.5 | 50 | 5.0 | 200 | 30 |
| | 2N3636# | 175 | 1000 | 50 | 50 | 0.5 | 50 | 5.0 | 150 | 30 |
| | 2N4929 | 150 | 500 | 25 | 10 | 0.5 | 10 | 1.0 | 100 | 20 |
| | MM4001 | 150 | 500 | 20 | 10 | 0.6 | 10 | 1.0 | _ | _ |
| | 2N3635# | 140 | 1000 | 100 | 50 | 0.5 | 50 | 5.0 | 200 | 30 |
| | 2N3634# | 140 | 1000 | 50 | 50 | 0.5 | 50 | 5.0 | 150 | 30 |
| | 2N3495 | 120 | 100 | 40 | 10 | 0.35 | 10 | 1.0 | 150 | 20 |
| | 2N5680 | 120 | 1000 | 40 | 250 | 0.6 | 250 | 25 | 30 | 100 |
| | MM4000 | 100 | 100 | 20 | 10 | 0.6 | 10 | 1.0 | l — | _ |
| | MM5007 | 100 | 2000 | 50 | 250 | 0.5 | 150 | 15 | 30 | 50 |
| | 2N4928 | 100 | 100 | 25 | 10 | 0.5 | 10 | 1.0 | 100 | 20 |
| | 2N5679 | 100 | 1000 | 40 | 250 | 0.6 | 250 | 25 | 30 | 100 |
| | MM5006 | 80 | 2000 | 50 | 200 | 0.5 | 150 | 15 | 30 | 50 |
| | 2N3494 | 80 | 100 | 40 | 10 | 0.3 | 10 | 1.0 | 200 | 20 |
| | 2N4236 | 80 | 3000 | 30 | 250 | 0.6 | 1000 | 125 | 3 | 100 |
| | 2N4036 | 65 | 1000 | 40 | 150 | 0.65 | 150 | 15 | 60 | 50 |
| | MM5005 | 60 | 2000 | 50 | 150 | 0.5 | 150 | 15 | 30 | 50 |
| | 2N4235 | 60 | 3000 | 30 | 250 | 0.6 | 1000 | 125 | 3 | 100 |
| | 2N4234 | 40 | 3000 | 30 | 250 | 0.6 | 1000 | 125 | 3 | 100 |

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TABLE 5. General-Purpose Amplifiers

These transistors are designed for dc to VHF amplifier applications, general-purpose switching applications, and complementary circuitry. Devices are listed in decreasing order of V(BR)CEO within each package group.

| D. d | Device | V(BR)CEO Volts Min | tT MHz @ Min | lc mA | IC mA Max | h _i Min | E @ | IC mA |
|---------|----------|--------------------------|--------------------|----------|-----------------|-----------------------|-----|----------|
| Package | Туре | MIII | territ | | | | | |
| N | | | | | T 1 | | | |
| TO-18 | 2N2896 | 90 | 120 | 50 | 1000 | 60 | 200 | 150 |
| | 2N3700# | 80 | 80 | 1.0 | 1000 | 50 | | 500 |
| | 2N2895 | 65 | 120 | 50 | 1000 | 40 | 120 | 150 |
| | 2N956 | 50 | 70 | 50 | | 40 | 120 | 150 |
| | 2N2897 | 45 | 100 | 50 | 1000 | 50 | 200 | 150 |
| | 2N718 | 40 | 50 | 50 | 1 | 40 | 120 | 150 |
| | 2N2221A# | 40 | 250 | 20 | 800 | 40 | 120 | 150 |
| | 2N2222A# | 40 | 300 | 20 | 800 | 100 | 300 | 150 |
| | 2N3946 | 40 | 300 | 10 | 200 | 50 | 150 | 10 |
| | 2N3947 | 40 | 300 | 10 | 200 | 100 | 300 | 10 |
| | 2N2222# | 30 | 250 | 20 | 800 | 100 | 300 | 150 |
| | 2N3302 | 30 | 250 | 50 | 500 | 100 | 300 | 150 |
| | 2N916° | 25 | 300 | 10 | | 50 | 200 | 10 |
| TO-39 | 2N1711 | 80 | 70 | 50 | | 100 | 300 | 150 |
| 10-39 | 2N3019# | 80 | 100 | 50 | 1000 | 100 | 300 | 150 |
| | 2N3020 | 80 | 80 | 50 | 1000 | 40 | 120 | 150 |
| | 2N1613# | 50 | 60 | 50 | 500 | 40 | 120 | 150 |
| | 2N2193A | 50 | 50 | 50 | 1000 | 40 | 120 | 150 |
| | 2N2270 | 45 | 100 | 50 | 1000 | 50 | 200 | 150 |

TABLE 5. General-Purpose Amplifiers (continued)

| | Device | V(BR)CEO Voits | | @ lc | IC mA | h | | @ lc |
|-----------|---|-------------------|------------|---------------|--------------|----------|-------------|------------|
| Package | Туре | Min | Min | mA | Max | Min | Max | mA |
| PN | | | | | | | | |
| TO-39 | 2N697 | 40 | 50 | 50 | | 40 | 120 | 150 |
| | 2N2218A# | 40 | 250 | 20 | 800 | 40 | 120 | 150 |
| | 2N2219A# | 40 | 300 | 20 | 800 | 100 | 300 | 150 |
| | 2N3053 | 40 | 100 | 50 | 700 | 50 | 250 | 150 |
| | 2N2218# | 30 | 250 | 20 | 800 | 40 | 120 | 150 |
| | 2N2219# | 30 | 250 | 20 | 800 | 100 | 300 | 150 |
| | 2N3300 | 30 | 250 | 50 | 500 | 100 | 300 | 150 |
| TO-46 | 2N5581** | 40 | 250 | 20 | 800 | 40 | 120 | 150 |
| | 2N5582** | 40 | 300 | 20 | 800 | 100 | 300 | 150 |
| TO-52 | MM3903 | 40 | 250 | 10 | 200 | 50 | 150 | 10 |
| | MM3904 | 40 | 300 | 10 | 200 | 100 | 300 | 10 |
| NP | • | | | | | | | |
| TO-18 | 2N4026 | 80 | 100 | 50 | 1000 | 15 | | 100 |
| 10-10 | 2N4026 2N4027 | 80 | 100 | 50 | 1000 | 10 | 1 = | 100 |
| | 2N4028 | 80 | 150 | 50 | 1000 | 40 | I = | 100 |
| | 2N4029 | 80 | 150 | 50 | 1000 | 25 | _ | 100 |
| | 2N2906A# | 60 | 200 | 50 | 600 | 40 | 120 | 150 |
| | 2N2907A† | 60 | 200 | 50 | 600 | 100 | 300 | 150 |
| | 2N3250A# | 60 | 250 | 10 | 200 | 50 | 150 | 10 |
| | 2N3251A# | 60 | 300 | 10 | 200 | 100 | 300 | 10 |
| | 2N2906# | 40 | 200 | 50 | 600 | 40 | 120 | 150 |
| | 2N2907# | 40 | 200 | 50 | 600 | 100 | 300 | 150 |
| | 2N3250 | 40 | 250 | 10 | 200 | 50 | 150 | 10 |
| | 2N3251 | 40 | 300 | 10 | 200 | 100 | 300 | 10 |
| | 2N869 | 18 | | | | | | |
| TO-39 | MM5007 | 100 | 30 | 50 | 2000 | 50 | 250 | 250 |
| | MM5006 | 80 | 30 | 50 | 2000 | 50 | 250 | 200 |
| | 2N4031 | 80 | 100 | 50 | 1000 | 10 | _ | 100 |
| | 2N4033# | 80 | 150 | 50 | 1000 | 25 | _ | 100 |
| | 2N4404 | 80 | 200 | 50 | 1000 | 40 | 120 | 150 |
| | 2N4405** | 80 | 200 | 50 | 1000 | 100 | 300 | 150 |
| | MM4036 | 65 | 60 | 50 | 1000 | 20 | 140 | 150 |
| | 2N4036 | 65 | 60 | 50 | 1000 | 40 | 140 | 150 |
| | 2N4037 | 65 | 60 | 50 | 1000 | 40 | _ | 150 |
| | MM5005 | 60 | 30 | 50 | 2000 | 50 | 250 | 150 |
| | 2N2904A# | 60 | 200 | 50 | 600 | 40 | 120 | 150 |
| | 2N2905A† 2N4030 | 60 60 | 200 100 | 50 50 | 600 | 100 | 300 | 150 |
| | 2N4030 2N4032 | 60 | 150 | 50 | 1000 1000 | 15 | - | 100 |
| | MM4037 | 40 | 60 | 50 | 1000 | 40 50 | - | 100 |
| | 2N1131A | 40 | 50 | 50 | 600 | 30 | 250 90 | 150 |
| | 2N1131A | 40 | 60 | 50 | 600 | 30 | 90 | 150 |
| | 2N2904# | 40 | 200 | 50 | 600 | 40 | 120 | 150 150 |
| | 2N2905# | 40 | 200 | 50 | 600 | 100 | 300 | 150 |
| | 2N1132* | 35 | 60 | 50 | 600 | 30 | 90 | 150 |
| TO-46 | 2N3485A** | 60 | 200 | 50 | 600 | 40 | 120 | 150 |
| | 2N3486A** | 60 | 200 | 50 | 600 | 100 | 300 | 150 |
| | 2N3673 | 50 | 200 | 50 | 600 | 75 | 225 | 150 |
| | 2N3486 | 40 | 200 | 50 | 600 | 100 | 300 | 150 |
| TO-52 | MM3906 | 40 | 250 | 10 | 200 | 100 | 300 | 10 |
| | MM3905 | 40 | 200 | 10 | 200 | 50 | 150 | 10 |
| available | | | ** 144(/14 | NTX available | · | | #JAN/JANTX/ | |

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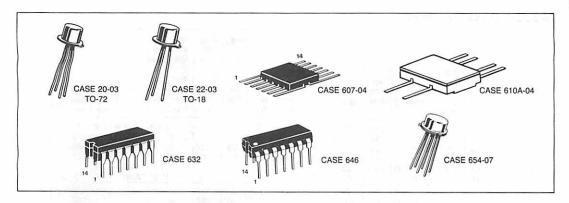
TABLE 6. Choppers

Devices are listed in decreasing V(BR)EBO-

| Package | Device | V(BR)EBO Min | V _{(BR)ECO} | Min hFE(inv) | Offset Voltage VEC(ofs) Max (mV) | On-State Resistance Fec(on) Max (Ω) |
|---------|---------|-----------------|----------------------|-----------------|--|---------------------------------------|
| TO-46 | 2N2946 | 40 | 35 | 3.0 | 2.0 | 45 |
| | 2N2946A | 40 | 35 | 20 | 2.0 | 8.0 |
| | 2N5230 | 30 | 20 | 15 | 0.5 | 8.0 |
| | 2N5231 | 30 | 20 | 15 | 0.8 | 10 |
| | 2N2945A | 25 | 20 | 30 | 1.0 | 6.0 |
| | 2N2945 | 25 | 20 | 4.0 | 1.0 | 35 |
| | 2N5229 | 15 | 10 | 15 | 0.5 | 6.0 |

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Multiple Small-Signal Transistors



The trend in electronic system design is toward the use of integrated circuits — to reduce component cost, assembly cost, and equipment cost. But ICs still aren't all things to all people, and for those circuit designs where ICs are not available, there is a noticeable swing towards the use of multiple devices.*

Motorola is reacting to this expanding market requirement by making available a large selection of Quad, Dual, and Darlington transistors for off-the-shelf delivery. The chips used in the Quad and Dual transistors are those that have emerged as the most popular ones for discrete transistor applications. But even be-

yond that, Motorola offers its entire vast repertoire of discrete small-signal transistors for multiple-device packaging. For special applications where the devices in this brochure might not quite fit the design requirements, special configurations can be supplied with quick turnaround time and at low premiums.

*Multiple devices, as described here, encompass two or more transistor chips in a single package. Included in this definition are the Darlington transistors which consist of two interconnected devices functioning as a single-stage amplifier.

Specification Tables

The following short form specifications include Quad and Dual transistors listed in alphanumeric order. Some columns denote two different types of data indicated by either **bold** or *italic* typeface. See key and headings for proper identification.

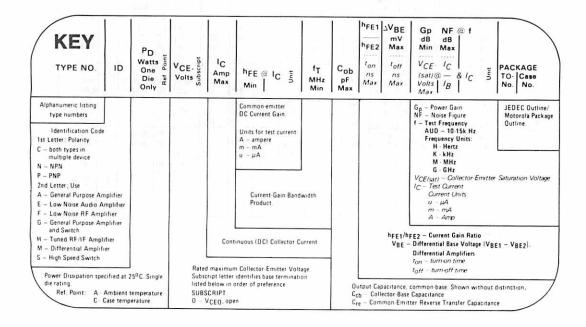


TABLE 1. Quad Transistors

| | | PD | | | | | | | | hFE1 —— hFE2 | AVBE mV Max | Gp dB Min | MB Max Typ* | f | | |
|--|--|---|--|-----------|---|--|--|--|---------------------------------------|---|---------------------------------------|---------------------------------------|----------------------------------|--|--|---|
| TYPE NO. | ID | Watte _ | V _{CE} - Volts | Subscript | IC Amp Max | hFE (| ⊋ IC | f _T MHz Min Typ* | C _{ob} pF Max Typ* | ton ns Max Typ* | ^t off ns Max Typ* | VCE (sat) (Volts Max | IC B IB | IC E | | CAGE Case No. |
| MHQ918 MHQ2221 MHQ2222† MHQ2369 MHQ2483 MHQ2484 | NF NG NG NS NA | 0.65 A 0.65 A 0.65 A 0.5 A 0.6 A 0.6 A | 15 40 40 15 40 40 | 000000 | 0.05 0.5 0.5 0.5 0.05 0.05 | 20 40 100 40 150 300 | 3.0 m 150 m 150 m 10 m 1.0 m | 600 200 200 450 50 | 2.0 8.0 8.0 4.0 | 25° 9.0° | 250° 15° | .4 .4 .25 | 10 10 3° 2° | 60 M 150 m 150 m 10 m AUD AUD | 116 116 116 116 116 116 | 632 632 632 632 632 632 |
| MHQ2906 MHQ2907† MHQ3467† MHQ3546 MHQ3798 MHQ3799 | PG PG PS PS PA PA | 0.65 A 0.65 A 0.9 A 0.5 A 0.5 A 0.5 A | 40 40 40 12 40 60 | 000000 | 0.6 0.6 1.0 0.2 0.05 0.05 | 40 100 20 30 150 300 | 150 m 150 m 500 m 10 m 0.1 m 0.1 m | 200 200 125 600 60 60 | 8.0 8.0 25 6.0 4.0 4.0 | 30° 30° 40 .15° | 100° 100° 90 25° | .4 .4 .5 .25 | 10 10 10 10 3° 2° | 150 m 150 m 500 m 10 m AUD AUD | 116 116 116 116 | 632 632 632 632 632 632 |
| MHQ4001A MHQ4002A MHQ4013†† MHQ4014 MHQ6001 MHQ6002 | NS NS NS NS CA | 0.75 A 0.75 A 0.75 A 0.75 A 0.65 A 0.65 A | 40 45 | 000000 | 1.5 1.5 1.5 1.5 0.5 | 30 30 35 35 40 100 | 500 m 500 m 500 m 500 m 150 m 150 m | 200 200 200 200 200 200 | 10 10 10 10 8.0 8.0 | 40 40 35 35 30 30 | 75 75 60 60 225* 225* | .52 .52 .52 .52 .52 .4 | 10 10 10 | 500 m 500 m 500 m 500 m 150 m 150 m | 116 116 116 116 | 632 632 632 632 632 632 |
| MHQ6100 MPQ918 MPQ1000 MPQ2221 MPQ2221A | CA NA NA NA | 0.5 A 0.625 A 0.65 A 0.65 A 0.65 A | 15 20 30 | 00000 | 0.05 0.05 0.5 0.5 0.5 | 75 20 50 40 40 | 1.0 m 3.0 m 10 m 150 m 150 m | 175° 600 175 200 200 | 4.5* 1.7 8.0 8.0 8.0 | 25° 25° | 250° 250° | .25 0.5 .4 .4 | 6.0 10 10 10 | 1.0 m 60 M 150 m 150 m 150 m | | 632 646 646 646 646 |
| MPQ2222 MPQ2222A MPQ2369 MPQ2483 MPQ2484 MPQ2906 MPQ2906A | NA NS NA NA PA PA | 0.65 A 0.65 A 0.5 A 0.625 A 0.625 A 0.65 A 0.65 A | 30 15 40 40 40 60 | 0000000 | 0.5 0.5 0.5 0.05 0.05 0.6 0.6 | 100 100 40 150 300 40 | 150 m 150 m 10 m 1.0 m 1.0 m 150 m | 200 450 50 50 200 200 | 8.0 4.0 8.0 8.0 | 25° 9.0° 30° 30° | 100° | .4 .25 .4 | 10 10 3° 2° 10 | 150 m 150 m 10 m AUD AUD 150 m 150 m | | 646 646 646 646 646 646 646 |
| MPQ2907 MPQ2907A MPQ3303 MPQ3467 MPQ3546 MPQ37254 MPQ3725A | PA PA NS PS PA NS NS | 0.65 A 0.65 A 0.65 A 0.75 A 1.0 A 1.0 A | 60 12 40 12 40 40 50 | 000000 | 0.6 0.6 1.0 1.0 0.2 1.0 1.0 | 100 100 40 20 30 25 30 35 | 150 m 150 m 300 m 500 m 10 m 500 m 500 m | 400 125 600 250 200 | 8.0 10 25 6.0 10 | 30° 15° 40° 15° 35° 35° 35° | 100° 25° 90 25° 60 60 | 0.5 .25 .45 | 1 10 1 10 5 10 5 10 | 150 m 1.0 A 500 m 10 m 500 m 500 n | | 646 646 646 646 646 646 646 |
| MPQ3762 MPQ3798 MPQ3799 MPQ3904 MPQ3906 | PS PA PA NG PG | 0.75 A 0.625 A 0.625 A 0.50 A | 40 60 4 40 | 00000 | 0.05 | 150 300 75 75 | 0.1 m 0.1 m 10 m | 60 | 4.0 | 37 | 136 | 0.2 | 3° 2° | AUD AUD 10 n | , | 646 646 646 646 |
| | | | | | | | <u> </u> | | | | | | | | | |

TABLE 1. Quad Transistors (continued)

| TYPE NO. | ID | PD E | ACE- point | I _C | hFE (| a. # | f _T | C _{ob} | hFE1 hFE2 | Max | Gp dB Min | Max Typ* | @1 &/c = | | KAGE ICase |
|---------------------|----------|------------------|----------------|----------------|-----------|----------------|----------------|-----------------|--------------|--------------|-----------------------|--|-------------------------|--------|---------------|
| | , | Die 5 Only | Volts g | Max | Min | PIC E | Min Typ* | Max Typ* | Max | Max Typ* | (sat) Volts Max | 'B | & IC 5 | No. | No. |
| MPQ6001 MPQ6002 | CG | 0.65 A 0.65 A | 30 O | 0.5 0.5 | 40 100 | 150 m 150 m | 200 200 | 8.0 8.0 | 30* | 225° 225° | 0.4 0.4 | 10 10 | 150 m | | 646 646 |
| MPQ6100 | CA | 0.5 A | 40 0 | 0.05 | 75 | 1.0 m | 50 | 4.0 | | | | 4. | AUD | ł | 646 646 |
| MPQ6100A MPQ6501 | CA | 0.5 A 0.65 A | 45 O 30 O | 0.05 | 150 40 | 1.0 m 150 m | 50 200 | 4.0 8.0 | 30. | 225* | 0.4 | 10 | 150 m | l | 646 |
| MPQ6502 | CG | 0.65 A | 30 O | 0.5 | 100 | 150 m | 200 | 8.0 | 30. | 225* | 0.4 | 10 | 150 m | | 646 |
| MPQ6600 | CA | 0.5 A | 40 O | 0.05 | 75 | 1.0 m | 50 | 4.0 | | | | 4. | AUD | \Box | 646 |
| MPQ6600A | CA | 0.5 A | 45 O | 0.05 | 150 | 1.0 m | 50 | 4.0 | | | 0.25 | 4.0 | 1.0 m | | 646 |
| MPQ6700 MPQ6842 | CA | 0.5 A 0.75 A | 40 O | 0.2 0.5 | 70 70 | 10 m | 200 300 | 4.5 4.5 | 45 | 150 | 0.25 0.15 | 4.0 | 1.0 m | | 646 646 |
| MPQ7041 | NA | 0.75 A | 150 0 | 0.5 | 25 | 1.0 m | 50 | 5.0 | " | , 55 | 0.5 | 10 | 20 m | 1 | 646 |
| MPQ7042 | NA | 0.75 A | 200 O | 0.5 | 25 | 1.0 m | 50 | 5.0 | | | 0.5 | 10 | 20 m | | 646 |
| MPQ7043 | NA | 0.75 A | 250 O | 0.5 | 25 | 1.0 m | 50 | 5.0 | | | 0.5 | 10 | 20 m | ├ | 646 |
| MPQ7051 MPQ7052 | CA | 0.75 A 0.75 A | 150 O 200 O | 0.5 0.5 | 25 25 | 1.0 m | 50 50 | 5.0 5.0 | | | 0.7 0.7 | 10 | 20 m | | 646 646 |
| MPQ7053 | CA | 0.75 A | 250 O | 0.5 | 25 | 1.0 m | 50 | 5.0 | | | 0.7 | 10 | 20 m | ł | 646 |
| MPQ7091 | PA | 0.75 A | 150 O | 0.5 | 25 | 1.0 m | 50 | 5.0 | | | 0.5 | 10 | 20 m | | 646 |
| MPQ7092 | PA | 0.75 A | 200 O | 0.5 | 25 35 | 1.0 m | 50 | 5.0 | | | 0.5 | 10 | 20 m | 1 | 646 |
| MPQ7093 MQ918 | PA NA | 0.75 A 0.55 A | 250 O 15 O | 0.5 0.05 | 50 | 10 m 3.0 m | 50 600 | 5.0 1.7 | | | 0.5 | 10 6.0 | 20 m | 1 | 646 |
| MQ930 | NA | 0.4 A | 45 O | 0.03 | 150 | 1.0 m | 260* | 6.0 | | | | | 1 | t- | 607 |
| MQ982 | PA | 0.4 A | 50 O | 0.6 | 40 | 150 m | 200 | 8.0 | | | 0.5 | 10 | 150 m | | 607 |
| MQ1120 | PA | 0.4 A | 30 O | 0.5 | 50 | 10 m | 200 | 8.0 | | | 0.10 | 10 | 10 m | | 607 |
| MQ1129 MQ2218 | NA NA | 0.4 A | 30 O | 0.5 0.5 | 100 40 | 10 m | 200 | 8.0 8.0 | | | 0.15 | 10 | 10 m | | 607 |
| MQ2218A | NA | 0.6 A | 40 0 | 0.5 | 40 | 150 m | 200 | 8.0 | | | 0.4 | 10 | 150 m | 1 | 607 |
| MQ2219 | NA | 0.6 A | 30 O | 0.5 | 100 | 150 m | 200 | 8.0 | | | 0.3 | 10 | 150 m | Ι . | 607 |
| MQ2219A | NA | 0.4 A | 30 0 | 0.5 | 100 | 150 m | 200 | 8.0 | | | 0.3 | 10 | 150 m | - | 607 |
| MQ2369 MQ2484 | NS NE | 0.40 A 0.4 A | 15 O 60 O | 0.5 | 40 100 | 10 m 10 u | 500 l | 4.0 6.0 | 15 | 20 | .25 | <i>10</i> 3.0 | 10 m | ł | 607 607 |
| MQ2904 | PG | 0.4 A | 40 0 | 0.03 | 40 | 150 m | 300 | 8.0 | 42 | 130 | .4 | 10 | 150 m | 1 | 607 |
| MQ2905A | PG | 0.4 A | 60 O | 0.6 | 100 | 150 m | 300 | 8.0 | 42 | 130 | .4 | 10 | 150 m | 1 | 607 |
| MQ3251 | PA | 0.40 A | 40 0 | 0.05 | 100 | 10 m | 300 | 6.0 | اء | | .25 | 10 | 10 m | | 607 |
| MQ3467 | PS | 0.40 A | 40 0 | 1.0 | 20 | 500 m | 150 | 20 | 40 | 110 | 0.5 | 10 | 500 m | ├ | 607 |
| MQ3725 MQ3762 | NS PS | 0.40 A 0.40 A | 40 O | 1.0 1.5 | 50 20 | 100 m | 200 150 | 10 20 | 45 40 | 75 110 | .26 1.0 | 10 | 100 m | 1 | 607 607 |
| MQ3798 | PA | 0.40 A | 60 0 | 0.05 | 150 | 100 u | 450* | 4.0 | 70 | ,,,, | 0.2 | 10 | 1.0 m | | 607 |
| MQ3799 | PA | 0.40 A | 60 O | 0.05 | 300 | 100 u | 450* | 4.0 | | | 0.2 | 10 | 1.0 m | | 607 |
| MQ3799A | PM | 0.40 A | 60 O | 0.05 | 300 | 100 u | 450* | 4.0 | 0.9 | 3.0 | 0.2 | 10 | 1.0 m | 1 | 607 |
| MQ6001 MQ6002 | CG | 0.40 A | 30 O | 0.5 | 40 | 150 m | 200 | 8.0 | 60 60 | 350 | 0.4 | 10 | 150 m | | 607 |
| MQ7001 | PA | 0.40 A | 30 O | 0.5 0.6 | 100 70 | 150 m | 200 | 8.0 8.0 | ᅃ | 350 | 0.4 | 10 | 150 m | | 607 607 |
| MQ7003 | NA | 0.40 A | 40 O | 0.05 | 50 | 10 m | 200 | 6.0 | | | .35 | 10 | 1.0 m | | 607 |
| MQ7004 | NA | 0.40 A | 13 0 | 0.2 | 30 | -10 m | 675* | 4.0 | | | 0.4 | 10 | 10 m | 1 | 607 |
| MQ7005 MQ7007 | NA PA | 0.4 A 0.4 A | 12 O 40 O | 0.05 0.2 | 30 30 | 3.0 m 1.0 m | 400 300 | 3.0 8.0 | | | 1.0 | 10 | 10 m 50 m | | 607 607 |
| MQ7021 | CG | 0.40 A | 40 0 | 0.05 | 50 | | 200 | | 200 | 72* | .35 | 10 | | _ | 607 |
| 2N5146 | PA | 0.40 A | 40 0 | 1.5 | 20 | 10 m 1.0 A | 150 | 6.0 20 | 28° 40 | 110 | 1.0 | 10 | 10 m | | 607 |
| 2N6501 | NS | 0.6 A | 40 0 | 1.0 | 50 | 100 m | 250 | 10 | 35 | 60 | | 10 | 100 m | l | 607 |

TABLE 2. QUAD TMOS FETS (N CHANNEL)

| | rds | (on) | | VGS | (t/h) | | l _D : | SS | V _{(BR} |)DSS | IG | SS | C | 55 | Cr | 88 | ton | toff |
|---------|-----|--------------------|-----|------------|-----------------|-------------|------------------|------------|------------------|------------|------|-----------|------|----------------------|------|------------------------|------|------|
| | (0) | (Ω) l _D | | () | V _{DS} | ۵ ا ما ا | (μA) | @ Vpc | (S) | @ 1g | (nA) | @ V=0 | (pF) | @ V _{DS} | (pF) | @ V _{DS} | (ns) | (ns) |
| Device | | (μA) | Min | Max | | (mA) | | (8) | | .ω (μΑ) | | 38 | Max | (8) | Max | (V) | Max | Max |
| MFQ930C | 1.4 | 1.0A | 1.0 | 3.5 | VGS | 1.0 | 10 | 35 | 35 | 10 | 50 | 15 | 70 | 25 | 18 | 25 | 15 | 15 |
| MFQ960C | 1.7 | 1.0A | 1.0 | 3.5 | VGS | 1.0 | 10 | 60 | 60 | 10 | 50 | 15 | 70 | 25 | 18 | 25 | 15 | 15 |
| MFQ990C | 2.0 | 1.0A | 1.0 | 3.5 | VGS | 1.0 | 10 | 90 | 90 | 10 | 50 | 15 | 70 | 25 | 18 | 25 | 15 | 15 |

TABLE 3. Dual Transistors

| TYPE NO. | ID | PD Watts 50 Only Conly Conly | ACE- Acrip | I _C Amp Max | hFE @ | lc in | f _T MHz Min | C _{ob} | hFE1hFE2 | Max foff ms Max | Gp dB Min VCE (sat)(Volts Max | NF (dB Max /C @ - /B | | KAGE Caso No. |
|---|----------------------------------|--|--|--|--|--|---|--|--------------------------------------|--|--|---------------------------------------|---|--|
| MD708 MD708A MD708AF MD708B MD708BF MD708F | NG NM NM NM NM | 0.55 A 0.55 A 0.35 A 0.55 A 0.35 A 0.35 A | 15 0 15 0 15 0 15 0 15 0 15 0 | 0.2 0.2 0.2 0.2 0.2 0.2 0.2 | 40 40 40 40 40 40 | 10 m 10 m 10 m 10 m 10 m | 300 300 300 300 300 300 | 5.0 5.0 5.0 5.0 5.0 5.0 | 35 0.9 0.9 0.8 0.8 35 | 75 5.0 5.0 10 10 | .20 .20 .20 .20 .20 .20 | 10 10 10 10 10 | 10 m 10 m 10 m 10 m 10 m 10 m | 654 654 610A 654 610A |
| MD918 MD918A MD918AF MD918B MD918F,BF MD982,F MD984 | NF NM NM NF PA PA | 0.55 A 0.55 A 0.35 A 0.55 A 0.35 A 0.40 A .575 A | 15 O 15 O 15 O 15 O 15 O 50 O 20 O | 0.05 0.05 0.05 0.05 0.05 0.6 0.2 | 50 50 50 50 50 40 25 | 3.0 m 3.0 m 3.0 m 3.0 m 3.0 m 150 m | 600 600 600 600 200 250 | 1.7 1.7 1.7 1.7 1.7 8.0 | 0.9 0.9 0.8 | 5.0 5.0 10 | 0.5 0.5 | 6.0 6.0 6.0 6.0 6.0 10 | 60 M 60 M 60 M 60 M 60 M 150 m | 654 654 610A 654 610A 610A |
| MD985 MD985F MD986 MD986F MD1120 MD1120F | C C C C S S | .575 A 0.35 A 0.55 A 0.35 A 0.575 A 0.35 A | 30 0 30 0 15 0 15 0 30 0 30 0 | 0.5 0.5 0.2 0.2 0.5 0.5 | 40 40 25 25 50 50 | 150 m 150 m 10 m 10 m 10 m | 200 200 200 200 200 200 | 8.0 8.0 4.0 4.0 8.0 8.0 | 0.8 | 10 10 | 0.5 0.5 0.3 0.3 .10 .10 | 10 10 10 10 10 10 | 150 m 150 m 10 m 10 m 10 m | 654 610A 654 610A 654 610 A |
| MD1121 MD1121F MD1122 MD1122F MD1123 MD1129 | NM NM NM NM PM NM | 0.575 A 0.35 A 0.575 A 0.35 A 0.575 A 0.575 A | 30 0 30 0 30 0 30 0 40 0 30 0 | 0.5 0.5 0.5 0.5 0.2 0.5 | 50 50 50 50 30 100 | 10 m 10 m 10 m 20 m 100 u 10 m | 200 200 200 200 250 200 | 8.0 8.0 8.0 4.0 8.0 | 0.9 0.9 0.9 0.8 0.9 | 10 10 5.0 5.0 10 6.0 | .10 .10 .10 .25 0.1 | 10 10 10 10 10 | 10 m 10 m 10 m 10 m 10 m 10 m | 654 654 654 654 654 654 |
| MD1129F MD1130 MD1130F MD1132 MD2060F MD2218 | NM PM PM NM NM NM | 0.35 A 0.575 A 0.35 A 0.3 A 0.35 A 0.575 A | 30 O | 0.5 0.2 0.2 0.05 0.5 0.5 | 100 100 100 50 30 40 | 10 m 100 u 100 u 1.0 m 0.1 m 150 m | 200 200 200 600 100 200 | 4.0 4.0 1.7 15 8.0 | 0.9 0.9 0.9 0.9 60 | 5.0 5.0 5.0 5.0 350 | .15 .25 .25 0.4 .10 0.4 | 10 10 10 8.0 10 | 10 m 10 m 10 m 10 m 150 m | 654 610 A 654 654 654 |
| MD2218A MD2218AF MD2218F MD2219 MD2219A MD2219AF | NG NG NG NG NG | 0.575 A 0.35 A 0.35 A 0.575 A 0.575 A 0.350 A | 30 O 30 O 30 O | 0.5 0.5 0.5 0.5 0.5 | 40 40 100 100 100 | 150 m 150 m 150 m 150 m 150 m | 200 200 200 200 200 200 | 8.0 8.0 8.0 8.0 8.0 | 45 60 60 45 45 | 310 310 350 350 310 310 | 0.3 0.4 0.4 0.3 0.3 | 10 10 10 10 10 | 150 m 150 m 150 m 150 m 150 m | 610A 610A 654 654 610A |
| MD2219F MD2369 MD2369A MD2369AF MD2369B MD2369BF | NG NS NM NM NM | 0.350 A 0.55 A 0.55 A 0.35 A 0.35 A | 15 O 15 O 15 O 15 O 15 O | 0.5 0.5 0.5 0.5 0.5 0.5 | 100 40 40 40 40 40 | 150 m 10 m 10 m 10 m 10 m | 200 500 500 500 500 500 | 8.0 4.0 4.0 4.0 4.0 | 60 15 0.9 0.9 0.8 0.8 | 350 20 5.0 5.0 10 | .25 .25 .25 .25 .25 | 10 10 10 10 10 | 10 m 10 m 10 m 10 m 10 m | 654 654 610 A 654 610 A |
| MD2369F MD2904 MD2904A . MD2904AF MD2904F MD2905 | PG PG PG PG PG | 0.35 A 0.575 A 0.575 A 0.350 A 0.350 A 0.575 A | 40 0 60 0 60 0 40 0 | 0.5 0.6 0.6 0.6 0.6 0.6 | 40 40 40 40 40 100 | 10 m 150 m 150 m 150 m 150 m 150 m | 500 200 200 200 200 200 200 | 8.0 8.0 8.0 8.0 8.0 | | 130 130 | 0.4 0.4 0.4 0.4 0.4 0.4 | 10 10 10 10 10 | 150 m 150 m 150 m 150 m 150 m | 654 654 610 A 610 A 654 |

TABLE 3. Dual Transistors (continued)

| TYPE NO. | ID | PD Watts 50 Only | A CE-Subscript | IC Amp Max | hFE @ | p lc is | f _T MHz Min Typ* | C _{ob} pF Max | hFE2 ton ns Max | ∆VBE mV Max toff ns Max | Gp dB Min VCE (sat) Volts Max | NF dB Max /C @ - | <u> </u> | (AGE Case No. |
|---|----------------------------------|--|--|--|--------------------------------------|---|---|--|-----------------------------------|--|---|----------------------------------|---|--|
| MD2905A MD2905AF MD2905F MD3250 MD3250A MD3250AF | PG PG PA PM PM | 0.575 A 0.35 A 0.35 A 0.57 5 0.57 5 0.35 A | 60 0 60 0 40 0 A40 0 A40 0 | 0.6 0.6 0.20 0.20 0.20 | 100 100 100 50 50 | 150 m 150 m 150 m 1.0 m 1.0 m | 200 200 200 200 200 200 200 | 8.0 8.0 8.0 6.0 6.0 6.0 | 45 45 45 0.9 0.9 | 130 130 130 5.0 5.0 | 0.4 0.4 0.4 .25 .25 | 10 10 10 10 10 | 150 m 150 m 150 m 10 m 10 m | 654 610A 610A 654 654 610A |
| MD3250F MD3251 MD3251A MD3251AF MD3251F MD3409 | PA PA PM PM PA NM | 0.35 A 0.575 A 0.575 A 0.35 A 0.35 A 0.575 A | 40 0 40 0 40 0 40 0 30 0 | 0.20 0.20 0.20 0.20 0.20 0.20 | 50 100 100 100 100 50 | 1.0 m 1.0 m 1.0 m 1.0 m 1.0 m | 200 250 250 250 250 250 250 | 6.0 6.0 6.0 6.0 6.0 8.0 | 0.9 0.9 0.8 | 5.0 5.0 | .25 .25 .25 .25 .25 .25 | 10 10 10 10 10 | 10 m 10 m 10 m 10 m 10 m | 610A 654 654 610A 610A 654 |
| MD3410 MD3467 MD3467F MD3725 MD3725F MD3762 | NM PS PS NS NS PS | 0.575 A 0.60 A 0.35 A 0.60 A 0.35 A 0.60 A | 30 0 0 40 0 0 40 0 0 40 0 | 0.5 1.5 1.5 1.0 1.0 | 50 20 20 50 50 20 | 10 m 500 m 500 m 100 m 100 m 1.0 A | 200 150 150 200 200 150 | 8.0 20 20 10 10 20 | 0.9 40 40 45 45 45 | 10 110 110 75 75 110 | .15 0.5 0.5 .26 .26 | 10 10 10 10 10 10 | 10 m 500 m 500 m 100 m 100 m 1.0 A | 654 654 610A 654 610A 654 |
| MD3762F MD5000 MD5000A MD5000B | PS PH PM PM | 0.35 A 0.3 A 0.3 A 0.3 A | 40 O 15 O 15 O 15 O | 1.5 0.05 0.05 0.05 | 20 20 20 20 | 1.0 A 3.0 m 3.0 m 3.0 m | 150 600 600 600 | 20 1.7 1.7 1.7 | 40 0.9 0.8 | 5.0 10 | 1.0 15 15 15 | 10 | 1.0 A 200 M 200 M 200 M | 610A 654 654 654 |
| MD6001 MD6001F MD6002 MD6002F | CG CG CG | .575 A 0.35 A .575 A 0.35 A | 30 O 30 O 30 O | 0.5 0.5 0.5 0.5 | 40 40 100 100 | 150 m 150 m 150 m 150 m | 200 200 200 200 | 8.0 8.0 8.0 8.0 | 60 60 60 | 350 350 350 350 | 0.4 0.4 0.4 0.4 | 10 10 10 10 | 150 m 150 m 150 m 150 m | 654 610A 654 610A |
| MD6003 MD6003F MD6100 MD6100F MD7000 MD7001 | CCCCAA | .575 A 0.35 A 0.5 A 0.35 A 0.575 A 0.6 A | 30 O 30 O 45 O 30 O 30 O | 0.5 0.5 0.05 0.05 0.5 0.6 | 70 70 100 100 70 70 | 150 m 150 m 0.1 m 0.1 m 150 m | 200 200 30 30 200 200 | 8.0 8.0 4.0 4.0 8.0 8.0 | | | 0.4 0.4 .25 .25 0.4 0.4 | 10 10 10 10 10 | 150 m 150 m 1.0 m 10 m 150 m 150 m | 654 610A 654 610A 654 654 |
| MD7001F MD7002 MD7002A MD7002B MD7003 MD7003A | PA NA NA NA NA NA | 0.350 A 0.575 A 0.575 A 0.575 A 0.555 A 0.555 A | 30 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 | 0.6 0.03 0.03 0.03 0.05 0.05 | 70 40 40 40 50 50 | 150 m 100 u 100 u 100 u 10 m | 200 200 200 200 200 200 200 | 8.0 6.0 6.0 6.0 6.0 | 0.75 0.85 0.75 | 25 15 25 | 0.4 .35 .35 .35 .35 | 10 10 10 10 10 | 150 m 10 m 10 m 10 m 1.0 m | 610 A 654 654 654 654 654 |
| MD7003AF MD7003B MD7003F MD7004 MD7004F MD7005 | NM NA NA NA PA | 0.35 A 0.55 A 0.35 A 0.55 A 0.35 A 0.55 A | 40 0 40 0 40 0 13 0 13 0 12 0 | 0.05 0.05 0.05 0.2 0.2 0.2 | 50 50 50 30 30 30 | 10 m 10 m 10 m 10 m 10 m 3.0 m | 200 200 200 675* 675* 650 | 6.0 6.0 6.0 4.0 4.0 3.0 | 0.75 0.85 | 25 15 | .35 .35 .35 0.4 0.4 0.4 | 10 10 10 10 10 | 1.0 m 1.0 m 1.0 m 10 m 10 m 10 m | 610 A 654 610 A 654 610 A 654 |
| | | | | | | | | | | | | | | |

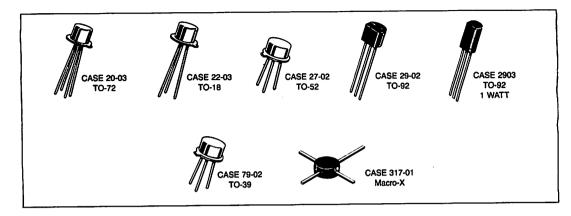
TABLE 3. Dual Transistors (continued)

| TYPE NO. | ID | Ouly Barrens Only Policy Volts Subscript | I _C Amp Max | hFE @ | o ic sign | fT MHz Min Typ* | C _{ob} pF Max Typ* | hFE2 | Max toff ms Max Typ | Gp dB Min VCE (sat) Volts Max | NF dB Max IC @ - | | | KAGE Case No. |
|--|---------------------------------------|--|--|--|--------------------------------------|---|--|--|----------------------------------|-------------------------------------|---|--|--|--|--|
| MD7005F MD7007 MD7007A MD7007B MD7007BF MD7007F | PA PA PM PM PM | 0.35 A 0.575 A 0.575 A 0.575 A 0.35 A 0.35 A | 12 0 40 0 50 0 60 0 40 0 40 0 | 0.05 0.2 0.2 0.2 0.2 0.2 | 30 30 30 30 30 30 | 3.0 m 1.0 m 1.0 m 1.0 m 1.0 m | 650 300 300 300 300 300 | 3.0 8.0 8.0 8.0 8.0 | 0.75 0.85 0.85 | 20 10 10 | 0.4 1.0 1.0 1.0 1.0 1.0 | 10 10 10 10 10 | 10 m 50 m 50 m 50 m 50 m 50 m | | 610A 654 654 654 610A |
| MD7021 MD7021F MD8001 MD8002 MD8003 2N2060 | 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 | 0.55 A 0.35 A 0.575 A 0.575 A 0.575 A 0.5 A | 000000 404040 4060 | 0.05 0.05 0.03 0.03 0.03 | 50 50 100 100 100 30 | 10 m 10 m 1.0 m 1.0 m 1.0 m 100 u | 200 260° 260° 260° 60 | 6.0 6.0 2.6* 2.6* 2.6* 15 | 28° 28° 0.9 | 72* 72* 15 15 15 5.0 | .35 .35 | 10 10 8.0 | 10 m 10 m | 78 | 654 610 A 654 654 654 654 |
| 2N2060A 2N2223 2N2223A 2N2453 2N2453A 2N2453A 2N2480 | MA MA MA MA MA MA | 0.5 A 0.5 A 0.5 A 0.5 A 0.5 A 0.3 A | 60 O 60 O 30 O 50 O 35 O | 0.5 0.5 0.5 0.05 0.05 0.05 | 30 25 25 80 80 30 | 100 u 100 u 100 u 10 u 10 u 1.0 m | 60 50 50 60 60 50 | 15 15 15 8.0 8.0 20 | 0.9 0.8 0.9 0.9 0.9 | 3.0 15 5.0 3.0 3.0 | 0.6 1.2 1.2 | 10 10 10 7.0 4.0 8.0 | 50 m 50 m 50 m 1000 H 1000 H | 78 78 78 78 78 78 | 654 654 654 654 654 654 |
| 2N2480A 2N2639 2N2640 2N2641 2N2642 2N2643 | NM NM NM NE NM | 0.3 A 0.3 A 0.3 A 0.3 A 0.3 A | 40 0 45 0 45 0 45 0 45 0 45 0 | 0.5 0.03 0.03 0.03 0.03 0.03 | 50 50 50 100 100 | 1.0 m 10 u 10 u 10 u 10 u | 50 80 80 80 80 | 18 8.0 8.0 8.0 8.0 | 0.8 0.9 0.8 0.9 0.8 | 5.0 5.0 10 5.0 10 | 1.3 | 10 4.0 4.0 4.0 4.0 4.0 | 50 m AUD AUD AUD AUD AUD | 78 78 78 78 78 78 78 | 654 654 654 654 654 654 |
| 2N2644 2N2652 2N2652A 2N2720 2N2721 2N2722 | NE NM NM NM NM | 0.3 A 0.3 A 0.3 A 0.3 A 0.3 A 0.3 A | 45 O 60 O 60 O 60 O 45 O | 0.03 0.5 0.5 0.04 0.04 0.04 | 100 50 50 30 30 50 | 10 u 1.0 m 1.0 m 0.1 m 0.1 m 1.0 u | 80 60 60 80 80 | 8.0 15 15 6.0 6.0 6.0 | 0.85 0.9 0.9 0.8 0.9 | 3.0 3.0 5.0 10 5.0 | 1.2 1.0 1.0 1.0 | 4.0 10 8.0 10 10 20 | 50 m 1000 H 10 m 10 m 10 m | 78 78 78 78 78 78 78 | 654 654 654 654 654 654 |
| 2N2903 2N2903A 2N2913 2N2914 2N2915 2N2916 | NM NM NE NE NM | 0.6 C 0.6 C 0.3 A 0.3 A 0.3 A | 30 0 30 0 45 0 45 0 45 0 45 0 | 0.05 0.05 0.03 0.03 0.03 0.03 | 125 125 60 150 60 150 | 1.0 m 1.0 m 10 u 10 u 10 u | 60 60 60 60 60 60 | 8.0 8.0 6.0 6.0 6.0 | 0.8 0.9 0.9 0.9 | 5.0 5.0 5.0 | | 7.0 7.0 4.0 3.0 4.0 3.0 | 1000 H 1000 H AUD AUD AUD AUD | 78 78 | 654 654 654 654 654 654 |
| 2N2917 2N2918 2N2919 2N2920 2N3043 2N3044 | MM MM MM MM NM | 0.3 A 0.3 A 0.3 A 0.3 A 0.25 A 0.25 A | 45 O 45 O 60 O 60 O 45 O 45 O | 0.03 0.03 0.03 0.03 0.03 0.03 | 60 150 60 150 100 | 10 u 10 u 10 u 10 u 10 u | 60 60 60 60 30 30 | 6.0 6.0 6.0 6.0 8.0 8.0 | 0.8 0.8 0.9 0.9 0.9 | 10 10 5.0 5.0 5.0 | | 4.0 3.0 4.0 3.0 5.0 5.0 | AUD AUD AUD AUD AUD AUD | | 654 654 654 654 610 |
| 2N3045 2N3046 2N3047 2N3048 2N3726 | NE NM NM NE PE | 0.25 A 0.25 A 0.25 A 0.25 A 0.25 A 0.4 A | 45 0 45 0 45 0 45 0 | 0.03 0.03 0.03 0.03 0.03 | 100 50 50 50 50 135 | 10 u 10 u 10 u 10 u 1.0 m | 30 30 30 30 200 | 8.0 8.0 8.0 8.0 8.0 | 0.9 0.8 0.9 | | | 5.0 5.0 5.0 5.0 4.0 | AUD AUD AUD AUD 1000 H | | 610 / 610 / 610 / 610 / 654 |

TABLE 3. Dual Transistors (continued)

| ID | Ouly Be Did Point | ACE: Action of the property of | IC Amp Max | h _{FE} (| a c sign | f _T MHz Min | C _{ob} pF Max | hFE2 lon ns Max | ΔVBE mV Max loff ns Max | dB Min VCE (sat): Volts | dB Max IC @— | | TO- | |
|----------------------------------|---|--|--|--|--|--|--|--------------------------------------|---|---|--|--|---|--|
| PE PE PE PM PM PM | 0.4 A 0.5 A 0.5 A 0.5 A 0.5 A 0.5 A | 45 O 60 O 60 O 60 O 60 O | 0.3 0.05 0.05 0.05 0.05 0.05 | 135 150 300 150 300 150 | 1.0 m 0.1 m 0.1 m 0.1 m 0.1 m 0.1 m | 200 100 100 100 100 100 | 8.0 4.0 4.0 4.0 4.0 4.0 | 0.9 0.8 0.8 0.9 | 2.5 5.0 5.0 3.0 | | 7.0 4.0 7.0 4.0 7.0 | 100 H 100 H 100 H 100 H 100 H | | 654 654 654 654 654 654 |
| PM PM PM PM PA PM | 0.5 A 0.5 A 0.5 A 0.5 A 0.5 A | 60 0 0 60 0 0 60 0 0 | 0.05 0.05 0.05 0.05 0.05 0.05 | 150 300 300 150 300 150 | 0.1 m 0.1 m 0.1 m 0.1 m 0.1 m 0.1 m | 100 100 100 100 100 100 | 4.0 4.0 4.0 4.0 4.0 4.0 | 0.95 0.9 0.95 0.8 | 1.5 3.0 1.5 5.0 | | 3.5 2.5 7.0 | AUD 100 H | | 654 654 654 610 A 610 A |
| PM PM PM PM PM CE | 0.5 A 0.5 A 0.5 A 0.5 A 0.5 A 0.25 A | 60 O 60 O 60 O 60 O 40 O | 0.05 0.05 0.05 0.05 0.05 0.05 | 300 150 150 300 300 100 | 0.1 m 0.1 m 0.1 m 0.1 m 0.1 m 150 m | 100 100 100 100 100 200 | 4.0 4.0 4.0 4.0 4.0 8.0 | 0.8 0.9 0.95 0.9 0.95 | 5.0 3.0 1.5 3.0 1.5 <i>340</i> | | | 100 H 100 H 100 H 100 H 100 H 1000 H | | 610 A 610 A 610 A 610 A 610 A |
| PM PM CE CE PM PM | 0.4 A 0.4 A 0.3 A 0.3 A 0.6 A 0.6 A | 60 0 60 0 40 0 40 0 40 0 | 0.3 0.6 0.6 0.05 0.05 | 135 135 100 40 50 50 | 1.0 m 1.0 m 150 m 150 m 1.0 m | 200 200 200 200 300 300 | 8.0 8.0 8.0 5.0 5.0 | 0.9 0.9 60 60 0.9 0.8 | 5.0 2.5 350 350 3.0 5.0 | | 4.0 8.0 8.0 4.0 | 1000 H 1000 H 1000 H AUD | | 654 654 654 654 654 654 |
| PE PM PM PE NG NG | 0.6 A 0.6 A 0.6 A 0.5 A 0.5 A | 40 0 0 40 0 0 40 0 0 40 0 | 0.05 0.05 0.05 0.05 0.6 0.6 | 50 50 50 50 40 100 | 1.0 m 1.0 m 1.0 m 1.0 m 150 m 150 m | 300 300 300 300 200 200 | 5.0 5.0 5.0 5.0 8.0 8.0 | 0.8 0.9 45 45 | 5.0 3.0 310 310 | 0.3 0.3 | 4.0 4.0 4.0 10 | AUD AUD AUD 150 m 150 m | | 654 610 A 610 A 610 A 654 654 |
| NG NG NS NS | 0.5 A 0.5 A 0.6 A 0.6 A | 60 O 60 O 40 O 40 O | 0.6 0.6 1.0 1.0 | 40 100 50 50 | 150 m 150 m 100 m 100 m | 200 200 250 250 | 8.0 8.0 10 10 | 47 47 35 35 | 140 140 60 60 | 0.4 0.3 0.3 | 10 10 10 10 | 150 m 150 m 100 m 100 m | | 654 654 654 610 A |
| | | | | | | | | | | | | | | |
| | PE PE PE PM PM PM PM PM PM PM PM PM PM PM PM PM | PE | PE | PE | PE | PE | ID | PE | PO | PD Watta Factor VCE Factor Watta VCE Watta Voits Factor Watta Voits Factor Watta Watta Watta Voits Factor Watta PO Watta Foundament PO Watta Foundament PO Watta Foundament PO Watta Foundament PO Watta Foundament PO Watta Foundament PO Watta Foundament PO Watta Foundament PO Watta Foundament PO Watta Foundament PO Watta Foundament Po Watta Foundament Po Po Po Po Po Po Po P | PO Watta South Po Watta South Po Watta South Po Watta South Po Watta South Po Watta South Po Watta South Po Watta South Po Watta South Po Watta South Po Watta South Po Watta Po W | PO Watts Foundament PO Watts PO | PO Westes VCE S VCE C S VCE C S VCE C VCE VC |

Field-Effect Transistors



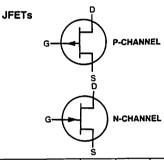
Motorola offers a line of field-effect transistors that encompasses the latest technology and covers the full range of FET applications. Included here is a wide variety of junction FETs, MOSFETs (with P- or N-channel polarity with both single and dual gates) and TMOS FETs. These FETs include devices developed for operation across the frequency range from dc to UHF in switching and amplifying applications. Package options

from low cost plastic to metal TO-72 packages are available. The selector guides on the following pages are designed to emphasize those FET families and device types that, by virtue of widespread industry use, ease of manufacture and, consequently, low relative cost, merit first consideration for new equipment design.

JFETs

TABLE 1. Switches and Choppers

JFETs operate in the depletion mode. They are available in both P- and N-channel and are offered in both metal and plastic packages. Applications include general-purpose amplifiers, switches and choppers, and RF amplifiers and mixers. These devices are economical and very rugged. The drain and source are interchangeable on many typical FETs.



P-Channel JFETs

| | | rds | (on) | VGS | i(off) | Į _D | ss | V(BR)GSS V(BR)GDO | Clss | Crss | ton | toff |
|-----------------|---------|------------|------|-----|-----------|----------------|------------|----------------------|-------------|-------------|-------------|-------------|
| Package TO - | Device | (Ω) MAX | (μΑ) | MIN | V) MAX | MIN | nA) MAX | (V) M!N | (pF) MAX | (pF) MAX | (ns) MAX | (ns) MAX |
| 92 | MPF970 | 100 | 1.0 | 5.0 | 12 | 15 | 100 | 30 | 12 | 5.0 | 8.0 | 25 |
| 92 | MPF971 | 250 | 1.0 | 1.0 | 7.0 | 2.0 | 80 | 30 | 12 | 5.0 | 10 | 120 |
| 72 | 2N3993 | 150 | _ | 4.0 | 9.5 | 10 | _ | 25 | 16 | 4.5 | _ | |
| 72 | 2N3994 | 300 | | 1.0 | 5.5 | 2.0 | _ | 25 | 16 | 4.5 | | |
| 72 | 2N3994A | 300 | _ | 1.0 | 5.5 | 2.0 | _ | 25 | 12 | 3.0 | <u> </u> | <u> </u> |

| Chann | el JFETs | | | _ | | | | | · | | | |
|-------|----------|----|-----|-------|-----|-----|---|----|----|-----|-----|----|
| 18 | MFE2012 | 10 | | 3.0 | 10 | 100 | | 25 | 50 | 20 | 16 | 37 |
| 18 | MFE2011 | 15 | 1.0 | 1.0 | 10 | 40 | _ | 25 | 50 | 20 | 10 | 20 |
| 18 | 2N4859A | 25 | | 2.0 | 6.0 | 50 | _ | 30 | 10 | 4.0 | 8.0 | 20 |
| 92 | MPF4859A | 25 | | 2.0 | 6.0 | 50 | _ | 30 | 10 | 4.0 | 8.0 | 20 |
| 18 | 2N4856A | 25 | | 4.0 | 10 | 50 | | 40 | 10 | 4.0 | 8.0 | 20 |
| | MPF4856A | 25 | | 4.0 | 10 | 50 | | 40 | 10 | 4.0 | 8.0 | 20 |
| 92_ | 2N4856 | 26 | | 4.0 | 10 | 50 | _ | 40 | 10 | 8.0 | 9.0 | 25 |
| 18 | | 25 | | 4.0 | 10 | 50 | | 40 | 10 | 8.0 | 9.0 | 25 |
| 92 | MPF4856 | 25 | | 1 7.0 | | | | | | | | |

TABLE 1. Switches and Choppers (continued)

N-Channel JFETs (continued)

| | | rds | (on) | VGS | i(off) | ΙD | ss | V(BR)GSS V(BR)GDO | Ciss | C _{rss} | ton | toff |
|-----------------|----------|------------|------------------------|-------|--------------------|-----|----------|----------------------|-------------------|------------------|-----------------|-------------|
| | | | @ | | v) | (n | 1A) | | | | | |
| Package TO - | Device | (Ω) MAX | l _D (μΑ) | MIN | MAX | MIN | MAX | (V) MIN | (pF) MAX | (pF) MAX | (ns) MAX | (ns) MAX |
| 18 | 2N4859 | 25 | | 4.0 | 10 | 50 | _ | 30 | 18 | 8.0 | 9.0 | 25 |
| 92 | MPF4859 | 25 | _ | 4.0 | 10 | 50 | _ | 30 | 18 | 8.0 | 9.0 | 25 |
| 18 | MFE2010 | 25 | 1.0 | 0.5 | 10 | 15 | _ | 25 | 50 | 20 | 10 | 35 |
| 18 | 2N4391 | 30 | 1.0 | 4.0 | 10 | 50 | 150 | 40 | 14 | 3.5 | 15 | 20 |
| 92 | MPF4391 | 30 | 1.0 | 4.0 | 10 | 60 | 130 | 20 | 10 | 3.5 | 15 | 20 |
| 92 | 2N638 | 30 | 1.0 | - | (12) | 50 | <u> </u> | 30 | 10 | 4.0 | 9.0 | 15 |
| 18 | 2N4091 | 30 | 1.0 | 5.0 | 10 | 30 | _ | 40 | 16 | 5.0 | 25 | 40 |
| 92 | MPF4091 | 30 | 1.0 | 5.0 | 10 | 30 | - | 40 | 16 | 5.0 | 25 | 40 |
| 92 | J111 | 30 | 1.0 | 3.0 | 10 | 20 | _ | 35 | 10 ^t . | 5.0 ^t | 13 | 35 |
| 18 | MFE2006 | 30 | 1.0 | -5.0 | -10 | 30 | _ | -30 | 16 | 5.0 | 20 | 40 |
| 18 | 2N3970 | 30 | 1.0 | 4.0 | 10 | 50 | 150 | 40 | 25 | 6.0 | 20 | 30 |
| 92 | MPF3970 | 30 | 1.0 | 4.0 | 10 | 50 | 150 | 40 | 25 | 6.0 | 20 | 30 |
| 18 | 2N4057A | 40 | | 2.0 | 6.0 | 20 | 100 | 40 | 10 | 3.5 | 10 | 40 |
| 92 | MPF4857A | 40 | ı | 2.0 | 6.0 | 20 | 100 | 40 | 10 | 3.5 | 10 | 40 |
| 18 | 2N860A | 40 | - | 2.0 | 6.0 | 20 | 100 | 30 | 10 | 3.5 | 10 | 40 |
| 92 | MPF4860A | 40 | _ | 2.0 | 6.0 | 20 | 100 | 30 | 10 | 3.5 | 10 | 40 |
| 18 | 2N4857 | 40 | | 2.0 | 6.0 | 20 | 100 | 40 | 18 | 8.0 | 10 | 50 |
| 92 | MPF4857 | 40 | - | 2.0 | 6.0 | 20 | 100 | 40 | 18 | 8.0 | 10 | 50 |
| 18 | 2N4860 | 40 | _ | 2.0 | 6.0 | 20 | 100 | 30 | 18 | 8.0 | 10 | 50 |
| 92 | MPF4860 | 40 | | 2.0 | 6.0 | 20 | 100 | 30 | 18 | 8.0 | 10 | 50 |
| 92 | 2N5653 | 50 | 1.0 | | (12) ^t | 40 | | 30 | 10 | 3.5 | 9.0 | 15 |
| 18 | 2N4092 | 50 | 1.0 | 2.0 | 7.0 | 15 | | 40 | 16 | 5.0 | 35 | 60 |
| 92 | MPF4092 | 50 | 1.0 | 2.0 | 7.0 | 15 | _ | 40 | 16 | 5.0 | 35 | 60 |
| 92 | J112 | 50 | 1.0 | 1.0 | 5.0 | 5.0 | _ | 35 | 10 ^t | 5.0t | 13 ^t | 35t |
| 18 | MFE2005 | 50 | 1.0 | -2.0 | - 8.0 | 15 | | -30 | 16 | 5.0 | 35 | 60 |
| 18 | 2N4392 | 60 | 1.0 | 2.0 | 5.0 | 25 | 75 | 40 | 14 | 3.5 | 15 | 35 |
| 92 | MPF4392 | 60 | 1.0 | 2.0 | 5.0 | 25 | 75 | 20 | 10 | 3.5 | 15 | 35 |
| 18 | 2N4858A | 60 | 1.0 | 0.8 | 4.0 | 8.0 | 80 | 40 | 10 | 3.5 | 16 | 80 |
| 92 | MPF4858A | 60 | 1.0 | 0.8 | 4.0 | 8.0 | 80 | 40 | 10 | 3.5 | 16 | 80 |
| 18 | 2N4861A | 60 | | 0.8 | 4.0 | 8.0 | 80 | 30 | 10 | 3.5 | 16 | 80 |
| 92 | MPF4861A | 60 | | 0.8 | 4.0 | 8.0 | 80 | 30 | 10 | 3.5 | 16 | 80 |
| 92 | 2N5639 | 60 | 1.0 | | (8.0) ^t | 25 | | 30 | 10 | 4.0 | 14 | 30 |
| 18 | 2N3971 | 60 | 1.0 | 2.0 | 5.0 | 25 | 75 | 40 | 25 | 6.0 | 30 | 60 |
| 92 | MPF3971 | 60 | 1.0 | 2.0 | 5.0 | 25 | 75 | 40 | 25 | 6.0 | 30 | 60 |
| 18 | 2N4858 | 60 | | 0.8 | 4.0 | 8.0 | 80 | 40 | 18 | 8.0 | 20 | 100 |
| 92 | MPF4858 | 60 | | 0.8 | 4.0 | 8.0 | 80 | 40 | 18 | 8.0 | 20 | 100 |
| 18 | 2N4861 | 60 | | 0.8 | 4.0 | 8.0 | 80 | 30 | 18 | 8.0 | 20 | 100 |
| 92 | MPF4861 | 60 | | 0.8 | 4.0 | 8.0 | 80 | 30 | 18 | 8.0 | 20 | 100 |
| 18 | 2N4093 | 80 | 1.0 | 1.0 | 5.0 | 80 | <u> </u> | 40 | 16 | 5.0 | 60 | 80 |
| 92 | MPF4093 | 80 | 1.0 | 1.0 | 5.0 | 80 | <u> </u> | 40 | 16 | 5.0 | 60 | 80 |
| 18 | MFE2004 | 80 | 1.0 | - 1.0 | - 6.0 | 8.0 | | -30 | 16 | 5.0 | 60 | 80 |
| 72 | MFE3002 | 100 | 10 V | | 3.0 | | 10 | 15 | 5.0 | 1.5 | | |
| 18 | 2N4393 | 100 | 1.0 | 0.5 | 3.0 | 5.0 | 30 | 40 | 14 | 3.5 | 15 | 50 |
| 92 | MPF4393 | 100 | 1.0 | 0.5 | 3.0 | 5.0 | 30 | 20 | 10 | 3.5 | 15 | 55 |
| 92 | 2N5654 | 100 | 1.0 | | (8.0) | 15 | | 25 | 10 | 3.5 | 14 | 30 |
| 92 | 2N5640 | 100 | 1.0 | | (6.0) | 5.0 | | 30 | 10 | 4.0 | 18 | 45 |

TABLE 1. Switches and Choppers (continued)

N-Channel JFETs (continued)

| | | rds | (on) | VGS | i(off) | ō | SS | V(BR)GSS V(BR)GDO | Ciss | Crss | ton | t _{off} |
|-----------------|---------|-----------------|-----------------|-------|-----------|-----|-----|----------------------|-----------------|-------------|-----------------|------------------|
| Package TO - | Device | (Ω) MAX | @ [D (Αμ) | MIN (| V) MAX | (IT | MAX | (V) MIN | (pF) MAX | (pF) MAX | (ns) MAX | (ns) MAX |
| 18 | 2N3972 | 100 | 1.0 | 0.5 | 3.0 | 5.0 | 30 | 40 | 25 | 6.0 | 80 | 100 |
| 92 | MPF3972 | 100 | 1.0 | 0.5 | 3.0 | 5.0 | 30 | 40 | 25 | 6.0 | 80 | 100 |
| 92 | J113 | 100 | 1.0 | 0.5 | 3.0 | 2.0 | | 35 | 10 ^t | 5.0t | 13 ^t | 35 ^t |
| 92 | BF246 | _ | _ | 0.5 | 14 | 10 | 300 | 25 | | | | |
| 92 | BF246A | 35 ^t | 1.0 | 1.5 | 4.0 | 30 | 80 | 25 | | | | |
| 92 | BF246B | 50t | 1.0 | 3.0 | 7.0 | 60 | 140 | 25 | _ | _ | <u> </u> | |
| 92 | BF246C | 65 ^t | 1.0 | 5.5 | 12.0 | 110 | 250 | 25 | _ | | | |
| 92 | J107 | 8 | | 0.5 | 4.5 | 100 | | 25 | | <u> </u> | | |
| 92 | J108 | . 8 | | 3.0 | 10.0 | 80 | | 25 | | | | |
| 92 | J109 | 12 | | 2.0 | 6.0 | 40 | | 25 | | | | <u> </u> |
| 92 | J110 | 18 | _ | 0.5 | 4.0 | 10 | | 25 | <u> </u> | L <u>-</u> | | |

t = typical

TABLE 2. Low-Frequency/Low-Noise

P-Channel JFETs

| | | Rel Yfs | Rel Yosi | Ciss | C _{rss} | V(BR)GSS V(BR)GDO | VGS | (off) | los | ss |
|-----------------|----------|---------------|---------------|---------------|------------------|----------------------|----------|-------|------|------------|
| | | | | | _ | , | (v | ן | (m | A) |
| Package TO - | Device | (mmho) MIN | (µmho) MAX | (pF) (MAX) | (pF) MAX | (V) MIN | MIN | MAX | MIN | MAX |
| 92 | MPF161 | 0.8 | 75 | 7.0 | 2.0 | 40 | 0.2 | 8.0 | -0.5 | <u>-14</u> |
| 72 | 2N5265 | 0.9 | 75 | 7.0 | 2.0 | 60 | 0.3 | 1.5 | 0.5 | 1.0 |
| 72 | MFE4009 | 1.0 | 20 | 20 | | 20 | | 5.0 | 1.0 | 3.0 |
| 72 | MFE4012 | 1.0 | 100 | 20 | | 20 | | 8.0 | 5.0 | 15 |
| 72 | 2N5267/8 | 1.0 | 20 | 20 | | 20 | | 6.0 | 1.0 | 6.0 |
| 72 | 2N3909 | 1.0 | 100 | 32 | 16 | 20 | 0.3 | 7.9 | 0.3 | 15 |
| 18 | MFE4007 | 1.0 | 20 | 25 | 7.0 | 25 | 0.3 | 1.5 | 0.3 | 1.2 |
| 28 | 2N2608 | 1.0 | 17 | _ | - | 30 | 1.0 | 4.0 | 0.9 | 4.5 |
| 92 | MPF2608 | 1.0 | _ | 17 | | 30 | 1.0 | 4.0 | 0.9 | 4.5 |
| 92 | 2N5460 | 1.0 | 50 | 7.0 | 2.0 | 40 | 0.75 | 6.0 | 1.0 | 5.0 |
| 72 | 2N5266 | 1.0 | 75 | 7.0 | 2.0 | 60 | 0.4 | 2.0 | 0.8 | 1.6 |
| 92 | 2N5463 | 1.0 | 75 | 7.0 | 2.0 | 60 | 0.5 | 4.0 | 1.0 | 5.0 |
| 72 | 2N3330 | 1.5 | 40 | 20 | | 20 | | 6.0 | 2.0 | 6.0 |
| 92 | MPF3330 | 1.5 | 40 | 20 | | 20 | <u> </u> | 6.0 | 2.0 | 6.0 |
| 18 | MFE4009 | 1.5 | 20 | 25 | 7.0 | 25 | 0.5 | 2.5 | 1.0 | 3.5 |
| 92 | 2N5461 | 1.5 | 50 | 7.0 | 2.0 | 40 | 1.0 | 7.5 | 2.0 | 9.0 |
| 72 | 2N5267 | 1.5 | 75 | 7.0 | 2.0 | 60 | 1.0 | 4.0 | 1.5 | 3.0 |
| 92 | 2N5464 | 1.5 | 75 | 7.0 | 2.0 | 60 | 0.8 | 4.5 | 2.0 | 9.0 |
| 92 | 2N4360 | 2.0 | 100 | 20 | 5.0 | 20 | 0.4 | 9.0 | 3.0 | 30 |
| 92 | 2N4342 | 2.0 | 75 | 20 | 5.0 | 25 | | 5.5 | 4.0 | 12 |
| 92 | 2N5462 | 2.0 | 50 | 7.0 | 2.0 | 40 | 1.8 | 9.0 | 4.0 | 16 |
| 72 | 2N5268 | 2.0 | 75 | 7.0 | 2.0 | 60 | 1.0 | 4.0 | 2.5 | 5.0 |

TABLE 2. Low-Frequency/Low-Noise (continued)

P-Channel JFETs

| | | Re Yfs | Rel Yos | Ciss | Crss | V(BR)GSS V(BR)GDO | VG | S(off) | ΙD | SS |
|-----------------|---------|---------------|---------------|---------------|-------------|----------------------|-----|--------|-----|-----|
| | ľ | | | | | | (| v) | (11 | nA) |
| Package TO - | Device | (mmho) MIN | (µmho) MAX | (pF) (MAX) | (pF) MAX | (V) MIN | MIN | MAX | MIN | MAX |
| 92 | 2N5465 | 2.0 | 75 | 7.0 | 2.0 | 60 | 1.5 | 6.0 | 4.0 | 16 |
| 72 | 2N3909A | 2.2 | 100 | 9.0 | 3.0 | 20 | 0.3 | 7.9 | 1.0 | 15 |
| 72 | 2N5269 | 2.2 | 75 | 7.0 | 2.0 | 60 | 2.0 | 6.0 | 4.0 | 8.0 |
| 18 | 2N2609 | 2.5 | | 30 | _ | 30 | 1.0 | 4.0 | 2.0 | 10 |
| 92 | MPF2609 | 2.5 | _ | 30 | | 30 | 1.0 | 4.0 | 2.0 | 10 |
| 72 | 2N5270 | 2.5 | 75 | 7.0 | 2.0 | 60 | 2.0 | 6.0 | 7.0 | 14 |

N-Channel JFETs

| | | Rel | | R _e l \ | | Ciss | C _{rss} | V(BR)GSS V(BR)GDO | | i(off) | l _D | SS |
|-----------------|----------|---------------|-----------------|--------------------|-----------------|------------------|------------------|----------------------|-----|------------------|----------------|-----------|
| Package TO - | Device | (mmho) MIN | @ f (MHz) | (µmho) MAX | @ f (MHz) | (pF) (MAX) | (pF) MAX | (V) MIN | MIN | V) MAX | (IT MIN | A) MAX |
| 18 | 2N3370 | 0.3 | 30 | 15 | 30 | 20 | 3.0 | 40 | _ | 3.2 | 0.1 | 0.6 |
| 92 | MPF111 | 0.5 | 10 | 200 | 10 | _ | _ | 20 | 0.5 | 10 | 0.5 | 20 |
| 92 | J201 | 0.5 | 20 | 1.0 ^t | 20 | 5.0 ^t | 2.0t | 40 | 0.3 | 1.5 | 0.2 | 1.0 |
| 18 | 2N3369 | 0.6 | 30 | 30 | 30 | 20 | 3.0 | 40 | | 6.5 | 0.5 | 2.5 |
| 92 | MPF109 | 0.8 | 15 | 75 | 15 | 7.0 | 3.0 | 25 | 0.2 | 8.0 | 0.5 | 24 |
| 18 | 2N4339 | 0.8 | 15 | 15 | 15 | 7.0 | 3.0 | 50 | 0.6 | 1.8 | 0.5 | 1.5 |
| 92 | MPF4339 | 0.8 | 15 | 15 | 15 | 7.0 | 3.0 | 50 | 0.6 | 1.8 | 0.5 | 1.5 |
| 18 | 2N3460 | 0.8 | 20 | 5.0 | 30 | 18 | 6.0 | 50 | | 1.8 | 0.2 | 1.0 |
| 18 | 2N3438 | 0.8 | 20 | 5.0 | 30 | 18 | 6.0 | 50 | _ | 2.3 | 0.2 | 1.0 |
| 72 | 2N4220 | 1.0 | 15 | 10 | 15 | 6.0 | 2.0 | 30 | _ | 4.0 | 0.5 | 3.0 |
| 92 | MPF4220 | 1.0 | 15 | 10 | 15 | 6.0 | 2.0 | 30 | | 4.0 | 0.5 | 3.0 |
| 72 | 2N4220A | 1.0 | 15 | 10 | 15 | 6.0 | 2.0 | 30 | | 4.0 | 0.5 | 3.0 |
| 92 | MPF4220A | 1.0 | 15 | 10 | 15 | 6.0 | 2.0 | 30 | | 4.0 | 0.5 | 3.0 |
| 72 | 2N5358 | 1.0 | 15 | 10 | 15 | 6.0 | 2.0 | 40 | 0.5 | 3.0 | 0.5 | 1.0 |
| 92 | J202 | 1.0 | 20 | 3.5t | 20 | 5.0 ^t | 2.0t | 40 | 0.8 | 4.0 | 0.9 | 4.5 |
| 18 | 2N3368 | 1.0 | 30 | 80 | 30 | 20 | 3.0 | 40 | | 11.5 | 2.0 | 12 |
| 72 | 2N5359 | 1.2 | 15 | 10 | 15 | 6.0 | 2.0 | 40 | 0.8 | 4.0 | 0.6 | 1.6 |
| 18 | 2N4340 | 1.3 | 15 | 30 | 15 | 7.0 | 3.0 | 50 | 1.0 | 3.0 | 1.2 | 3.6 |
| 72 | 2N5360 | 1.4 | 15 | 20 | 15 | 6.0 | 2.0 | 40 | 0.8 | 4.0 | 0.5 | 2.5 |
| 94 | 2N5458 | 1.5 | 15 | 50 | 15 | 7.0 | 3.0 | 25 | 1.0 | 7.0 | 2.0 | 9.0 |
| 72 | 2N5361 | 1.5 | 15 | 20 | 15 | 6.0 | 2.0 | 40 | 1.0 | 6.0 | 2.5 | 5.0 |
| 92 | J203 | 1.5 | 20 | 10 ^t | 20 | 5.0 ^t | 2.0 ^t | 40 | 2.0 | 10 | 4.0 | 20 |
| 18 | 2N3459 | 1.5 | 20 | 20 | 30 | 18 | 6.0 | 50 | _ | 3.4 | 0.8 | 4.0 |
| 72 | 2N3821 | 1.5 | 15 | 10 | 15 | 6.0 | 3.0 | 50 | | 4.0 | 0.5 | 2.5 |
| 92 | MPF3821 | 1.5 | 15 | 10 | 15 | 6.0 | 3.0 | 50 | _ | 4.0 | 0.5 | 2.5 |
| 18 | 2N3437 | 1.5 | 20 | 20 | 30 | 18 | 6.0 | 50 | _ | 4.8 | 0.8 | 4.0 |
| 92 | 2N5457 | 2.0 | 15 | 50 | 15 | 7.0 | 3.0 | 25 | 0.5 | 6.0 | 1.0 | 5.0 |
| 92 | 2N5459 | 2.0 | 15 | 50 | 15 | 7.0 | 3.0 | 25 | 2.0 | 8.0 | 4.0 | 16 |
| 72 | 2N4221 | 2.0 | 15 | 20 | 15 | 6.0 | 2.0 | 30 | | 6.0 | 2.0 | 6.0 |

t = typical

TABLE 2. Low-Frequency/Low-Noise (continued)

N-Channel JFETs

| | | RelY | fs | R _e Y | os | C _{ISS} | Crss | V(BR)GSS V(BR)GDO | VGS | | lps | |
|-----------------|----------|-----------------|------------|--------------------|------------|------------------|-------------|----------------------|--------------|-----|-----|-----|
| | | | @ | | @ | 6.5 | (-D | 00 | (' | ו | (m. | 4) |
| Package TO - | Device | (mmho) MIN | f (MHz) | (µmho) MAX | f (MHz) | (pF) (MAX) | (pF) MAX | (V) MIN | MIN | MAX | MIN | MAX |
| 92 | MPF4221 | 2.0 | 15 | 20 | 15 | 6.0 | 2.0 | 30 | _ | 6.0 | 2.0 | 6.0 |
| 72 | 2N4221A | 2.0 | 15 | 20 | 15 | 6.0 | 2.0 | 30 | | 6.0 | 2.0 | 6.0 |
| 92 | MPF4221A | 2.0 | 15 | 20 | 15 | 6.0 | 2.0 | 30 | | 6.0 | 2.0 | 6.0 |
| 72 | 2N5362 | 2.0 | 15 | 40 | 15 | 6.0 | 2.0 | 40 | 2.0 | 7.0 | 4.0 | 8.0 |
| 72 | 2N3822 | 2.0 | 15 | 20 | 15 | 6.0 | 3.0 | 50 | | 6.0 | 2.0 | 10 |
| 92 | MPF3822 | 2.0 | 15 | 20 | 15 | 6.0 | 3.0 | 50 | | 6.0 | 2.0 | 10 |
| 18 | 2N4341 | 2.0 | 15 | 60 | 15 | 7.0 | 3.0 | 50 | 2.0 | 6.0 | 3.0 | 9.0 |
| 72 | 2N4222 | 2.5 | 15 | 40 | 15 | 6.0 | 2.0 | 30 | | 8.0 | 5.0 | 15 |
| 92 | MPF4222 | 2.5 | 15 | 40 | 15 | 6.0 | 2.0 | 30 | <u> </u> | 8.0 | 5.0 | 15 |
| 72 | 2N4222A | 2.5 | 15 | 40 | 15 | 6.0 | 2.0 | 30 | | 8.0 | 5.0 | 15 |
| 92 | MPF4222A | 2.5 | 15 | 40 | 15 | 6.0 | 2.0 | 30 | | 8.0 | 5.0 | 15 |
| 72 | 2N5363 | 2.5 | 15 | 40 | 15 | 6.0 | 2.0 | 40 | 2.5 | 8.0 | 7.0 | 14 |
| 18 | 2N3458 | 2.5 | 20 | 35 | 30 | 18 | 6.0 | 50 | | 7.8 | 3.0 | 15 |
| 18 | 2N3436 | 2.5 | 20 | 35 | 30 | 18 | 6.0 | 50 | L <i>-</i> _ | 9.8 | 3.0 | 15 |
| 72 | 2N5364 | 2.7 | 15 | 60 | 15 | 6.0 | 2.0 | 40 | 2.5 | 8.0 | 9.0 | 18 |
| 92 | 2N5670 | 3.0 | 15 | 75 | 15 | 7.0 | 3.0 | 25 | 2.0 | 8.0 | 8.0 | 20 |
| 18 | 2N4398 | 12 ^t | 0.001 | | T - | 14 | 3.5 | 40 | 0.5 | 3.0 | 5.0 | 30 |
| 72 | 2N5556 | 6.5 | 0.001 | 20 | 15 | 6.0 | 3.0 | 30 | 0.2 | 4.0 | 0.5 | 2.5 |
| 72 | 2N4117 | 20 | 0.001 | 3.0 | 10 | 3.0 | 1.5 | 40 | 0.6 | 1.8 | 30 | 90 |
| 92 | MPF4117 | 20 | 0.001 | 3.0 | 10 | 3.0 | 1.5 | 40 | 0.6 | 1.8 | 30 | 90 |
| 72 | 2N4117A | 70 | 0.001 | 3.0 | 10 | 3.0 | 1.5 | 40 | 0.6 | 1.8 | 30 | 90 |
| 92 | MPF4117A | 70 | 0.001 | 3.0 | 10 | 3.0 | 1.5 | 40 | 0.6 | 1.8 | 30 | 90 |
| 72 | 2N4118 | 80 | 0.001 | 5.0 | 10 | 3.0 | 1.5 | 40 | 1.0 | 3.0 | 80 | 240 |
| 92 | MPF4118 | 80 | 0.001 | 5.0 | 10 | 3.0 | 1.5 | 40 | 1.0 | 3.0 | 80 | 240 |
| 72 | 2N4118A | 80 | 0.001 | 5.0 | 10 | 3.0 | 1.5 | 40 | 1.0 | 3.0 | 80 | 240 |
| 92 | MPF4118A | 80 | 0.001 | 5.0 | 10 | 3.0 | 1.5 | 40 | 1.0 | 3.0 | 80 | 240 |
| 72 | 2N4119 | 100 | 0.001 | 10 | 10 | 3.0 | 1.5 | 40 | 2.0 | 6.0 | 200 | 600 |
| 92 | MPF4119 | 100 | 0.001 | 10 | 10 | 3.0 | 1.5 | 40 | 2.0 | 6.0 | 200 | 600 |
| 72 | 2N4119A | 100 | 0.001 | 10 | 10 | 3.0 | 1.5 | 40 | 2.0 | 6.0 | 200 | 600 |
| 92 | MPF4119A | 100 | 0.001 | 10 | 10 | 3.0 | 1.5 | 40 | 2.0 | 6.0 | 200 | 600 |

t = typical

MOSFETs

MOSFETs are available in either depletion/enhancement or enhancement mode (in general, depletion/enhancement devices are operated in the depletion mode and are referred to as depletion devices). They are available in both N- and P-channel, and both single gate and dual gate construction. Some MOSFETs are also offered with input diode protection which reduces the chance of damage from static charge in handling.

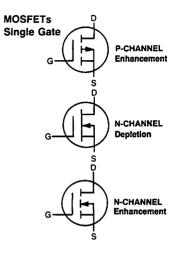


TABLE 2. Low-Frequency/Low-Noise (continued)

P-Channel MOSFETs

| | | Re | Y _{fs} | Ciss | Crss | V(BR)DSS | VGS | (TH) | D | SS |
|-----------------|---------|--------|-----------------|---------------|-------------|------------|------|-----------|-----------|-----------|
| Package TO - | Device | (mmho) | (µmho) MAX | (pF) (MAX) | (pF) MAX | (V) MIN | | /) MAX | (m MIN | A) MAX |
| 72 | 3N155 | 1.0 | 60 | 5.0 | 1.3 | -35 | -1.5 | -3.2 | - | -1.0 |
| 72 | 3N156 | 1.0 | 60 | 5.0 | 1.3 | -35 | -3.0 | -5.0 | _ | -1.0 |
| 72 | 3N157 | 1.0 | 60 | 5.0 | 1.3 | -35 | -1.5 | -3.2 | _ | -1.0 |
| 72 | 3N155A | 1.0 | 60 | 5.0 | 1.3 | -35 | -1.5 | -3.2 | | -0.25 |
| 72 | 3N156A | 1.0 | 60 | 5.0 | 1.3 | -35 | -3.0 | -5.0 | | -0.25 |
| 72 | 3N157A | 1.0 | 60 | 5.0 | 1.3 | -50 | -1.5 | -3.2 | - | -0.25 |
| 72 | 3N158 | 1.0 | 60 | 5.0 | 1.3 | -35 | -3.0 | -5.0 | - | -1.0 |
| 72 | 3N158A | 1.0 | 60 | 5.0 | 1.3 | -25 | -2.0 | -6.0 | _ | -20 |
| 18 | MFE823 | 1.0 | _ | 6.0 | 1.5 | -50 | -3.0 | -5.0 | _ | -0.25 |
| 72 | MFE3003 | | _ | 5.0 | 1.0 | - 15 | _ | -4.0 | | 10 |

N-Channel MOSFETs

| 18 | 2N3796 | 0.4 | 1.8 | 7.0 | 0.8 | 25 | | -7.0 | 2.0 | 6.0 |
|----|---------|-----|-----|-----|-----|----|-----|------|-----|-----|
| 18 | MFE825 | 0.5 | | 4.0 | 0.7 | 20 | _ | | 1.0 | 25 |
| 72 | 2N4351 | 1.0 | | 5.0 | 1.3 | 25 | 1.0 | 5.0 | _ | 10 |
| 72 | 3N169 | 1.0 | _ | 5.0 | 1.3 | 25 | 0.5 | 1.5 | _ | 10 |
| 72 | 3N170 | 1.0 | _ | 5.0 | 1.3 | 25 | 1.0 | 2.0 | _ | 10 |
| 72 | 3N171 | 1.0 | _ | 5.0 | 1.3 | 25 | 1.5 | 3.0 | _ | 10 |
| 72 | MFE3002 | _ | _ | 5.0 | 1.0 | 15 | | 3.0 | - | 10 |
| 18 | 2N3797 | 1.5 | _ | 8.0 | 0.8 | 25 | - | -7.0 | 2.0 | 6.0 |

TABLE 3. High-Frequency Amplifiers

N-Channel JFETs

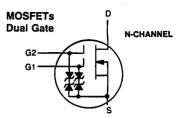
| N-Channe | JFETS_ | | | | | | | | | | | | | - |
|-----------------|----------|--------------------|------------|------------------|------------|------------------|------------------|------------------|--------------------|----------------------|----------|------|-----|-----|
| | | R _e Y | fsl | Rel Y | 08 | Clas | Crss | | NF | V(BR)GSS V(BR)GDO | VGS | | lDi | |
| | | | @ | | @ | | | | @ | | (V | ן ו | (m | (A) |
| Package TO - | Device | (mmho) MIN | f (MHz) | (µmho) MAX | f (MHz) | (pF) (MAX) | (pF) MAX | (dB) MAX | RG = 1K f (MHz) | (V) MIN | MIN | MAX | MIN | MAX |
| 92 | 2N5669 | 1.6 | 100 | 100 | 100 | 7.0 | 3.0 | 2.5 | 100 | 25 | 1.0 | 6.0 | 4.0 | 10 |
| 92 | MPF108 | 1.6 | 100 | 200 | 100 | 6.5 | 2.5 | 3.0 | 100 | 25 | | 8.0 | 1.5 | 24 |
| 92 | MPF102 | 1.6 | 100 | 200 | 100 | 7.0 | 3.0 | | | 25 | | 8.0 | 2.0 | 20 |
| 92 | 2N3819 | 1.6 | 100 | 1 | - | 8.0 | 4.0 | | | 25 | | 8.0 | 2.0 | 20 |
| 92 | 2N5668 | 1.0 | 100 | 50 | 100 | 7.0 | 3.0 | 2.5 | 100 | 25 | 0.2 | 4.0 | 1.0 | 5.0 |
| 72 | 2N4224 | 1.7 | 200 | 200 | 200 | 6.0 | 2.0 | | | 30 | 0.1 | 8.0 | 20 | 20 |
| 92 | MPF4224 | 1.7 | 200 | 200 | 200 | 6.0 | 2.0 | | | 30 | 0.1 | 8.0 | 2.0 | 20 |
| 92 | 2N5484 | 2.5 | 100 | 75 | 100 | 5.0 | 1.0 | 3.0 | 100 | 25 | 0.3 | 3.0 | 1.0 | 5.0 |
| 72 | MFE2000 | 2.5 | 0.001 | 50 | 0.001 | 5.0 | 1.0 | 4.0 | 400 | -25 | -0.5 | -0.4 | 4.0 | 10 |
| 92 | 2N5670 | 2.5 | 100 | 150 | 100 | 7.0 | 3.0 | 2.5 | 100 | 25 | 2.0 | 8.0 | 8.0 | 20 |
| 92 | 2N5246 | 2.5 | 400 | 100 | 400 | 4.5 | 1.0 | | | 30 | 0.5 | 4.0 | 1.5 | 7.0 |
| 72 | 2N4223 | 2.7 | 200 | 200 | 200 | 6.0 | 2.0 | 5.0 | 200 | 30 | 0.1 | 8.0 | 3.0 | 18 |
| 92 | MPF4223 | 2.7 | 200 | 200 | 200 | 6.0 | 2.0 | 5.0 | 200 | 30 | 0.1 | 8.0 | 3.0 | 18 |
| 92 | 2N5485 | 3.0 | 400 | 100 | 400 | 5.0 | 1.0 | 4.0 | 400 | 25 | 1.0 | 4.0 | 4.0 | 10 |
| 92 | J305 | 3.0t | 400 | 80t | 100 | 3.0t | 0.8 ^t | 4.0t | 400 | 30 | 0.5 | 3.0 | 1.0 | 8.0 |
| 72 | 2N3823 | 3.2 | 200 | 200 | 200 | 6.0 | 2.0 | 2.5 | 100 | 30 | <u> </u> | 8.0 | 4.0 | 20 |
| 92 | MPF3823 | 3.2 | 200 | 200 | 200 | 6.0 | 2.0 | 2.5 | 100 | 30 | <u> </u> | 8.0 | 4.0 | 20_ |
| 92 | 2N5486 | 3.5 | 400 | 100 | 400 | 5.0 | 1.0 | 4.0 | 400 | 25 | 2.0 | 6.0 | 8.0 | 20 |
| 72 | MFE2001 | 4.0 | 0.001 | 75 | 0.001 | 5.0 | 1.0 | 4.0 | 400 | -25 | -2.0 | -6.0 | 8.0 | 20 |
| 72 | 2N4416 | 4.0 | 400 | 100 | 400 | 4.0 | 0.8 | 4.0 | 400 | 30 | 2.0 | 6.0 | 5.0 | 15 |
| 92 | MPF4416 | 4.0 | 400 | 100 | 400 | 4.0 | 0.8 | 4.0 | 400 | 30 | 2.0 | 6.0 | 5.0 | 15 |
| 72 | 2N4416A | 4.0 | 400 | 100 | 400 | 4.0 | 0.8 | 4.0 | 400 | 30 | 2.0 | 6.0 | 5.0 | 15 |
| 92 | MPF4416A | 4.0 | 400 | 100 | 400 | 4.0 | 0.8 | 4.0 | 400 | 30 | 2.0 | 6.0 | 5.0 | 15 |
| 92 | 2N5245 | 4.0 | 400 | 100 | 400 | 4.5 | 1.0 | 4.0 | 400 | 30 | 1.0 | 6.0 | 5.0 | 15 |
| 92 | 2N5247 | 4.0 | 400 | 150 | 400 | 4.5 | 1.0 | 4.0 | 400 | 30 | 1.5 | 8.0 | 8.0 | 24 |
| 92 | J304 | 4.2t | 400 | 80t | 100 | 3.0 ^t | 0.8 ^t | 4.01 | 400 | 30 | 2.0 | 6.0 | 5.0 | 15 |
| 52 | U308 | 10 | 0.001 | 150 | 100 | 5.0 | 2.5 | 3.0t | 450 | 25 | 1.0 | 6.0 | 12 | 60 |
| 52 | U309 | 10 | 0.001 | 150 | 100 | 5.0 | 2.5 | 3t | 450 | 25 | 1.0 | 4.0 | 12 | 30 |
| 52 | U310 | 10 | 0.001 | 150 | 100 | 5.0 | 2.5 | зt | 450 | 25 | 2.5 | 6.0 | 24 | 60 |
| 92 | J308 | 12 ^t | 100 | 250 ^t | 100 | 7.5 | 2.5 | 1.5 ^t | 100 | 25 | 1.0 | 6.5 | 12 | 60 |
| 92 | J309 | 12 ^t | 100 | 250t | 100 | 7.5 | 2.5 | 1.5 ^t | 100 | 25 | 1.0 | 4.0 | 12 | 30_ |
| 92 | J310 | 12 ^t | 100 | 250 ^t | 100 | 7.5 | 2.5 | 1.5 ^t | 100 | 25 | 2.0 | 6.5 | 24 | 60 |
| 72 | MFE3004 | 2.0 | 0.001 | | <u> </u> | 4.5 | 0.4 | 4.5 | 200 | 20 | += | -5.0 | | 10 |
| 72 | 3N128* | 5.0 | 0.001 | 500 | 200 | 7.0 | 0.28 | 5.0 | 200 | -50_ | _ \ -0.5 | -8.0 | 5.0 | 25 |

t = typical

^{*}N-Channel MOSFET

MOSFETs (continued) TABLE 4. Dual Gate MOSFETs

These devices are especially suited for RF amplifier and mixer applications in TV tuners, radio, etc. The Dual Gate construction also allows easy AGC control with very low power.



Dual Gate MOSFETs

| | \ | R _e Y | fs | R _e Y | os | Ciss | Crss | | NF | V _(BR) GSS V _(BR) GDO | VGS | (off) | פו | SS |
|-----------------|---------|------------------|-----------------|--------------------|-----------------|------------------|------|-------------|-------------------------|--|-----------|------------------|-----------|-----|
| Package TO - | Device | (mmho) MIN | @ f (MHz) | (µmho) MAX | @ f (MHz) | (pF) (MAX) | (pF) | (dB) MAX | @ RG = 1K f (MHz) | (V) | (\ MIN | /) MAX | (m MiN | MAX |
| 72 | MFE140 | 10 | 0.001 | | <u> </u> | 7.0 | 0.05 | 3.5 | 105 | ±7.0 | | 4.0 | 3.0 | 30 |
| 72 | MFE521 | 10 | 0.001 | | | 4.0 | 0.02 | 3.5 | 200 | 10 | 0.5 | 2.0 | 5.0 | 20 |
| 72 | 3N211 | 17 | 0.001 | | | | 0.05 | 3.5 | 200 | ±6.0 | -0.2 | -5.5 | 6.0 | 40 |
| M | MPF211 | 17 | 0.001 | | | | 0.05 | 3.5 | 200 | ±6.0 | -0.2 | -5.5 | 6.0 | 40 |
| 72 | 3N206 | 7.0 | 0.001 | | | _ | 0.03 | 4.0 | 45 | 25 | -0.2 | -4.0 | 3.0 | 15 |
| 72 | 3N213 | 15 | 0.001 | | | | 0.05 | 4.0 | 45 | ±6.0 | -0.2 | -5.5 | 6.0 | 40 |
| М | MPF213 | 15 | 0.001 | | | | 0.05 | 4.0 | 45 | ±6.0 | -0.2 | -5.5 | 6.0 | 40 |
| 72 | 3N212 | 17 | 0.001 | | | - | 0.05 | 4.0 | 45 | ±6.0 | -0.2 | -4.0 | 6.0 | 40 |
| М | MPF212 | 17 | 0.001 | | | _ | 0.05 | 4.0 | 45 | ±6.0 | -0.2 | -4.0 | 6.0 | 40 |
| 72 | 3N203 . | 7.0 | 0.001 | | | 4.3t | 0.03 | 4.5 | 200 | ±6.0 | -0.2 | -5.0 | 3.0 | 11 |
| М | MPF203 | 7.0 | 0.001 | | | 4.3 ^t | 0.03 | 4.5 | 200 | ±6.0 | -0.2 | -5.0 | 3.0 | 11 |
| 72 | 3N201 | 8.0 | 0.001 | | | 4.5t | 0.03 | 4.5 | 200 | ±6.0 | -0.2 | -5.0 | 6.0 | 30 |
| М | MPF201 | 8.0 | 0.001 | | | 4.3t | 0.03 | 4.5 | 200 | ±6.0 | -0.2 | ~ 5.0 | 6.0 | 30 |
| 72 | 3N202 | 8.0 | 0.001 | | | 4.3t | 0.03 | 4.5 | 200 | ±6.0 | -0.2 | ~5.0 | 6.0 | 30 |
| м | MPF202 | 8.0 | 0.001 | | | 4.3 ^t | 0.03 | 4.5 | 200 | ±6.0 | -0.2 | -5.0 | 6.0 | 30 |
| 72 | MFE121 | 10 | 0.001 | | | 6.0 | 0.02 | 5.0 | 60 | ±7.0 | | -4.0 | 5.0 | 30 |
| 72 | MFE120 | 8.0 | 0.001 | | | 7.0 | 0.02 | 5.0 | 105 | ±7.0 | | -4.0 | 2.0 | 18 |
| 72 | MFE130 | 8.0 | 0.001 | • | | 7.0 | 0.05 | 5.0 | 105 | ±7.0 | | -4.0 | 3.0 | 30 |
| 72 | MFE122 | 8.0 | 0.001 | | | 7.0 | 0.02 | 5.0 | 200 | ±7.0 | _ | -4.0 | 2.0 | 30 |
| 72 | MFE131 | 8.0 | 0.001 | | | 7.0 | 0.05 | 5.0 | 200 | ±7.0 | | -4.0 | 3.0 | 30 |
| 72 | MFE132 | 8.0 | 0.001 | | | 7.0 | 0.05 | 5.0 | 200 | ±7.0 | _ | -4.0 | 3.0 | 30 |
| 72 | 3N204 | 10 | 0.001 | | | _ | 0.03 | 5.0 | 400 | 25 | -0.2 | -4.0 | 6.0 | 30 |
| 72 | 3N205 | 10 | 0.001 | | | _ | 0.03 | 5.0 | 400 | 25 | -0.2 | -4.0 | 6.0 | 30 |
| 72 | 3N209 | 10 | 0.001 | | | 7.0 | 0.03 | 6.0 | 500 | ±7.0 | -0.1 | -4.0 | 5.0 | 30 |
| М | MPF521 | 10 | 0.001 | | | 4.0 | 0.03 | 3.5 | 200 | 12 | _ | | _ | _ |

t = typical M = Macro-X Package

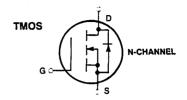
Small-Signal TMOS

TABLE 5. TMOS Power MOSFETs

Power MOSFETs, Motorola trademark TMOS, are FET transistors with an oxide insulated gate which controls vertical current flow.

This basic description fits a number of structures and process titles including Vertical DMOS, HEXMOS, TMOS, UMOS, Vertical MOS, and VMOS.

There are subtle parametric tradeoffs with these different products but they all exhibit higher input impedance, faster switching, enhanced thermal stability, and easier paralleling than bipolar transistors. In addition, they have lower "on" resistance and higher power handling capability than conventional horizontal MOSFETs or JFETs.



N-Channel

| -Channel | | rds(| on) | VGS | (t/h) | IDSS | V _{(BR)DSS} | IGSS | Ciss | Crss | ton | toff |
|-----------------|---------|------------|--------------|-----|------------------|-------------|----------------------|-------------|-----------------|-------------|------------------|-------------|
| Package TO - | Device | (Ω) MAX | ≽ d ® | MIN | /) MAX | (µA) MAX | (V) MIN | (nA) MAX | (pF) MAX | (pF) MAX | (ns) MAX | (ns) MAX |
| 39 | MFE930 | 1.4 | 1.0 | 1.0 | 3.5 | 10 | 35 | 50 | 70 | 18 | 15 | 15 |
| 92 | MPF930 | 1.4 | 1.0 | 1.0 | 3.5 | 10 | 35 | 50 | 70 | 18 | 15 | 15 |
| 39 | MFE960 | 1.7 | 1.0 | 1.0 | 3.5 | 10 | 60 | 50 | 70 | 18 | 15 | 15 |
| 92 | MPF960 | 1.7 | 1.0 | 1.0 | 3.5 | 10 | 60 | 50 | 70 | 18 | 15 | 15 |
| 39 | MFE990 | 2.0 | 1.0 | 1.0 | 3.5 | 10 | 90 | 50 | 70 | 18 | 15 | 15 |
| 92 | MPF990 | 2.0 | 1.0 | 1.0 | 3.5 | 10 | 90 | 50 | 70 | 18 | 15 | 15 |
| 18 | MFE9200 | 6.4 | .250 | 1.0 | 4.0 | 10 | 200 | 50 | 90 | 3.5 | 15 | 15 |
| 92 | MPF9200 | 6.4 | .250 | 1.0 | 4.0 | 10 | 200 | 50 | 90 | 3.5 | 15 | 15 |
| 92 | BS107 | 14 | 0.20 | 1.0 | 2.6 | 0.03 | 200 | 10 | 90 | 3.5 | 15 | 15 |
| 92 | BS170 | 5.0 | 0.20 | 0.8 | 3.0 | 0.5 | 60 | 10 | 38t | 4.5t | 10 | 10 |
| 226AE | MPF910 | 5.0 | 0.50 | 0.8 | 2.5 | 10 | 60 | 10 | 38 ^t | 4.5t | 5.0t | 5.0 |
| 92 | MPF6659 | 1.8 | 1.0 | 0.8 | 2.0 | 500 | 35 | 100 | 50 | 10 | 5.0 | 5.0 |
| 92 | MPF6660 | 3.0 | 1.0 | 0.8 | 2.0 | 500 | 60 | 100 | 50 | 10 | 5.0 | 5.0 |
| 92 | MPF6661 | 4.0 | 1.0 | 0.8 | 2.0 | 500 | 90 | 100 | 50 | 10 | 5.0 | 5.0 |
| 39 | 2N6659 | 1.8 | 1.0 | 0.8 | 2.0 | 10 | 35 | 100 | 50 | 10 | 5.0 | 5.0 |
| 39 | 2N6660 | 3.0 | 1.0 | 0.8 | 2.0 | 10 | 60 | 100 | 50 | 10 | 5.0 | 5.0 |
| 39 | 2N6661 | 4.0 | 1.0 | 0.8 | 2.0 | 10 | 90 | 100 | 50 | 10 | 5.0 | 5.0 |
| 226AE | MPF1010 | + = | <u> </u> | 0.3 | 2.5 | 10 | 100 | 10 | 35 ^t | 6t | 5.0 ^t | 5.0 |
| 39 | MFE910 | 5.0 | 0.5 | 0.3 | 2.5 | 10 | 60 | 10 | _ | _ | 5.0 ^t | 5.0 |

t = typical

GaAs FETs

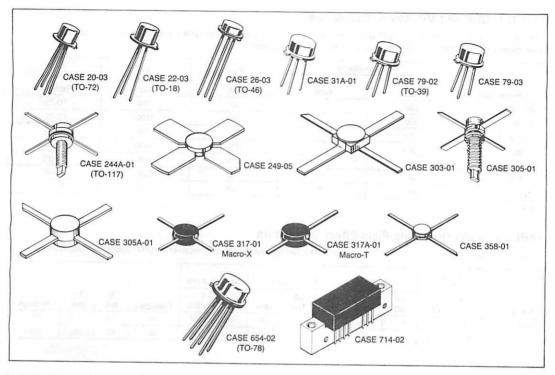
TABLE 6. GaAs Dual Gate Field-Effect Transistors

The GaAs Dual Gate FETs listed here are for low noise and high gain receiver amplifier and mixer applications.

| | l _D : | SS /P | N | olse Figu | re | G | ain | Ind3 | MdB | [| | | |
|-------------|------------------|----------|----------|-----------|----------------|-----------|----------|------|-----|----------------------|----------|----------|---------|
| Device Type | IDSS (mA) | Vds | NF dB | f MHz | I _D | dB Min | f MHz | dB | dBm | V _{(BR)DSX} | ID MA | PT mW | Package |
| MRF966 | 50 | 5.0 | 1.2* | 1000 | 10 | 15 | 1000 | -65° | 10* | 10 | 60 | 350 | 317-1 |
| MRF967 | 50 | 5.0 | 1.2* | 1000 | 10 | 13 | 1000 | -65* | 10* | 10 | 60 | 350 | 358-1 |

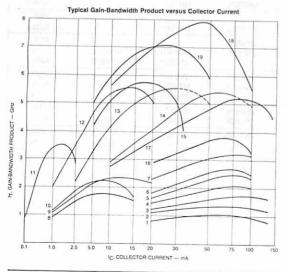
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RF Small-Signal Transistors



Motorola's small-signal, low power RF transistor product range includes transistors with gain-bandwidths of 1.0 GHz to 8.0 GHz operating at currents of 0.25 mA to over 140 mA.

These devices are available in a wide variety of package types; metal can, plastic Macro-X and Macro-T, hermetic ceramic and microminiature. Most of these transistors are fully characterized with y or s parameters; and in addition, there are non-saturated switching characteristics, low power driver specifications, and noise figure limits. QPL types with JAN, JTX and JTXV processing levels are available as well as Hi Rel processing to meet unique customer requirements.



RF Small-Signal Transistors

Motorola small-signal and medium power RF transistors with gain-bandwidth products from 1.0 GHz to 8.0 GHz operate with currents from 0.25 mA to over 140 mA. The following chart, combined with the tables of package options, enables the circuit designer to select the optimum device from Motorola's wide range of transistor/package combinations.

- 2N3866, 2N3866A, MM8000
- 2N5160, MM4018, PNP
- 2N3948, 2N4427, MRF207
- 2N5109, 2N5943, MM8001, MM8002
- 2N5583, PNP
- 6 2N5836, 2N5837
- MRF511, MRF517, MRF525
- 2N2857, 2N3839, 2N5179,
- MRF501, MRF502
- 2N6304, 2N6305, BFX89, BFY90
- 10 2N4957, 2N4958, 2N4959, PNP MRF931
- 2N6603, BFR90, MRF901, MRF904 2N6604, BFR91, MRF911, MRF914 13
- BFR96, MRF961, MRF962, MRF965
- BFW92A MRF559

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- MRF580, MRF581, MRF586, MRF587
- MRF571, MRF572, MRF573
- MRF536, MRF534, MM4049, PNP

TABLE 1. UHF and Microwave Oscillators

The transistors listed below are for UHF and microwave oscillator applications as initial signal sources or as output stages of limited range transmitters. Devices are listed in order of increasing output power.

| | Test Co | nditions | Pout | fτ | |
|-------------|----------|--------------------------|-----------|------------|---------|
| Device Type | f MHz | V _{CC} Volts | mW Min | MHz Typ | Package |
| 2N5179 | 500 | 10 | 20 | 1800 | TO-72 |
| | 500 | 10 | 30 | 1800 | TO-72 |
| 2N2857 | 500 | 6.0 | 30 | 1800 | TO-72 |
| 2N3839 | 1680 | 20 | 200 | 1400 | TO-39 |
| MM8009 | | 20 | 300 | 1400 | TO-39 |
| 2N5108 | 1680 | | | 2200 | TO-46 |
| MRF905 | 1680 | 20 | 500* | | |
| 2N3866 | 400 | 15 | 1000 | 1000 | TO-39 |

^{*}Typical

TABLE 2. GaAs Dual Gate Field-Effect Transistors

The GaAs Dual Gate N-Channel FET's listed here are for low noise and high gain receiver amplifier and mixer applications.

| | lp: Ty | | N | oise Figu | re | G | aln | IMD3 | P ₁ dB | | | _ | |
|-------------|--------------|-----|----------|-----------|----------------|-----------|----------|------|-------------------|----------------------|----------------------|----------------------|---------|
| Device Type | IDSS (mA) | Vds | NF dB | f MHz | l _D | dB Min | f MHz | dB | dBm | V _{(BR)DSX} | I _D mA | P _T mW | Package |
| | 50 | 5.0 | 1.2* | 1000 | 10 | 15 | 1000 | -65° | 10° | 10 | 60 | 350 | 317-1 |
| MRF966 | 50 | 5.0 | 1.2* | 1000 | 10 | 13 | 1000 | -65° | 10° | 10 | 60 | 350 | 358-1 |

^{*}Typical

TABLE 3. Low-Noise Transistors

The low-noise devices listed are produced with carefully controlled r_b ' and t_T to optimize device noise performance. Devices listed in the matrix are classified according to noise figure performance versus frequency.

| | | | Frequer | icy MHz | | | |
|----------|------------------|------------------|------------------|------------------|----------------------------|------------------|-------------------|
| NF dB | 60 | 100 | 200 | 450 | 1000 | 2000 | Polarity |
| 1.5 | 2N5829 2N5031 | 2N5829 2N5031 | MRF904 | MRF571 | MRF572 | | PNP NPN |
| 2.0 | 2N4957 2N5032 | 2N4957 2N5032 | 2N5829 2N5031 | MRF904 | MRF901 | | PNP NPN |
| 2.5 | 2N4958 2N5032 | 2N4958 2N5032 | 2N4957 2N5032 | 2N5829 2N5031 | MRF901 2N6603 | MRF572 MRF573 | PNP NPN NPN |
| 3.0 | 2N4959 2N2857 | 2N4959 2N2857 | 2N4958 2N5032 | 2N4957 2N5032 | 2N5829 MRF901 2N6604 | 2N6603 | PNP NPN NPN |
| 3.5 | 2N4959 2N5179 | 2N4959 2N5179 | 2N4959 2N2857 | 2N4958 2N5032 | 2N4957 2N5031 | MRF901 | PNP NPN |
| 4.0 | 2N4959 2N5179 | 2N4959 2N5179 | 2N4959 2N5179 | 2N4959 2N2857 | 2N4958 2N5031 | 2N6604 | PNP NPN |
| 4.5 | 2N4959 2N5179 | 2N4959 2N5179 | 2N4959 2N5179 | 2N4959 2N2857 | 2N4959 2N5032 | | PNP NPN |

TABLE 4. CATV, MATV, and Class A Linear Transistors

The devices listed below are excellent for Class A linear CATV/MATV applications and are listed according to increasing gain-bandwidth (f_T). More information concerning the device for your specific linear design needs can be obtained through your local Motorola Sales Office or Motorola distributor.

| | Nominal Test | | Noise Figure | | Distortion S | pecifications | | |
|----------------|----------------------------|------------------|---------------------|---------------------|---------------------|--------------------------|-------------------------|---------|
| Device Type | Conditions VCE/IC Volts/mA | fy MHz Min | Max/Freq. dB/MHz | 2nd Order IMD | 3rd Order IMD | 12 Ch. Cross- Mod. | Output Level dBmV | Package |
| MRF501 | 6/5 | 600 | 4.5*/200 | | | | | TO-72 |
| MRF502 | 6/5 | 800 | 4.0°/200 | | | | | TO-72 |
| 2N5179 | 6/5 | 900 | 4.5/200 | | | | <u> </u> | TO-72 |
| BFY90 | 5/2 | 1000 | 5.0/500 | _ | | | | TO-72 |
| 2N6305 | 5/10 | 1200 | 5.5/450 | | | | - | TO-72 |
| BFX89 | 5/25 | 1200 | 6.5/500 | | | | | TO-72 |
| 2N5109 | 15/50 | 1200 | 3.0*/200 | | | | | TO-39 |
| 2N5943 | 15/50 | 1200 | 3.4/200 | - 50 | | -42 | +50 | TO-39 |
| 2N6304 | 5/10 | 1400 | 4.5/450 | _ | | | | TO-72 |
| MRF511 | 20/80 | 1500 | 7.3*/200 | -50 | -65 | -57 | +50 | 244A-01 |
| 2N5947 | 20/75 | 1500° | 3.8/200 | | -55 | -60 | +50 | 244A-01 |
| MRF517 | 15/60 | 2200 | 7.5/300 | -60 | -72 | -57 | +45 | TO-39 |
| BFW92A | 5/2 | 4500° | 3.0*/500 | | | | | 317A-01 |
| MRF586 | 14/70 | 4500° | 3.0/500 | -50 | -72 | | +50 | TO-39 |
| BFR90 | 10/14 | 5000° | 2.4*/500 | | | | | 317A-01 |
| BFR91 | 5/35 | 5000° | 1.9*/500 | | | | | 317A-01 |
| BFR96 | 10/50 | 5000* | 3.0*/500 | | | | | 317A-01 |
| MRF961 | 10/50 | 5000° | 2.0*/500 | | | | 1 | 317-01 |
| MRF962 | 10/50 | 5000° | 2.0*/500 | | | | | 303-01 |
| MRF965 | 10/50 | 5000° | 2.0*/500 | | | | | TO-46 |
| MRF581 | 10/75 | 5000° | 3.0/500 | | -65 | | +50 | 317-01 |
| MRF587 | 14/70 | 5500° | 3.0/500 | -52 | -72 | | +50 | 244A-01 |

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TABLE 5. High-Speed Switches

The transistors listed below are for use as high-frequency current-mode switches. They are also suitable for RF amplifier and oscillator applications. The devices are listed in ascending order of collector current.

| Device Type | Test Conditions IC/VCE mA/Volts | fT MHz Min | rb'Cc Max | Package |
|-------------|---------------------------------|------------------|--------------|---------|
| 2N3959 | 10/10 | 1300 | 25 | TO-18 |
| 2N3960 | 10/10 | 1600 | 40 | TO-18 |
| 2N5835 | 10/6.0 | 2500 | 5.0** | TO-72 |
| MM4049* | 20/5.0 | 4000 | 15 | TO-72 |
| MRF914 | 20/10 | 4500** | | TO-72 |
| 2N5842 | 25/4.0 | 1700 | 40 | TO-72 |
| 2N5841 | 25/4.0 | 2200 | 25 | TO-72 |
| 2N5943 | 50/15 | 1200 | 5.5** | TO-39 |
| 2N5583* | 50/10 | 1000 | 8.0** | TO-39 |
| 2N5836 | 50/6.0 | 2000 | 6.0** | TO-46 |
| 2N5837 | 100/3.0 | 1700 | 6.0** | TO-46 |

^{*}PNP **Typ

Class C Amplifiers

The transistors listed in these tables are specified for operation in Class C RF power amplifier circuits. The tables are arranged by increasing frequency of operation first, then by increasing output power. The first table contains those devices specified at 12.5 Vdc, while the following table contains devices specified at 28 Vdc.

TABLE 6. Low-Voltage Class C Amplifiers

| Device Type | Frequency (MHz) | P _{in} | Pout (w) | G _{pe} dB | Voltage (V) | Case Outline |
|------------------|--------------------|-----------------|-------------|-----------------------|----------------|-----------------|
| MRF8003 | 27 | 0.05 | 0.5 | 10.0 | 12.5 | TO-39 |
| MRF8004 | 27 | 0.35 | 3.5 | 10.0 | 12.5 | TO-39 |
| MRF402 | 50 | 0,1 | 1.0 | 10.0 | 12.5 | TO-39 |
| MRF229 | 90 | 0.15 | 1.5 | 10.0 | 12.5 | TO-39 |
| MRF230 | 90 | 0.15 | 1.5 | 10.0 | 12.5 | TO-39 |
| MRF604 | 175 | 0.1 | 1.0 | 10.0 | 12.5 | TO-46 |
| 2N4427 | 175 | 0.1 | 1.0 | 10.0 | 12.0 | TO-39 |
| MRF607 | 175 | 0.12 | 1.75 | 11.5 | 12.5 | TO-39 |
| 2N6255 | 175 | 0.5 | 3.0 | 7.8 | 12.5 | TO-39 |
| MRF237* | 175 | 0.25 | 4.0 | 12.0 | 12.5 | TO-39 |
| MRF207 | 220 | 0.15 | 1.0 | 8.2 | 12.5 | TO-39 |
| MRF225 | 225 | 0.18 | 1.5 | 9.0 | 12.5 | TO-39 |
| MRF227* | 225 | 0.13 | 3.0 | 13.5 | 12.5 | TO-39 |
| 2N3948 | 400 | 0.25 | 1.0 | 6.0 | 13.6 | TO-39 |
| 2N6256 | 470 | 0.1 | 0.5 | 7.0 | 12.5 | 249-5 |
| MRF515 | 470 | 0.12 | 0.75 | 8.0 | 12.5 | TO-39 |
| MRF581 | 470 | 0.05 | 1.2 | 13.8 | 12.5 | 317-1 |
| | 470 | 0.32 | 2.0 | 8.0 | 12.5 | TO-39 |
| MRF629* | 470 | 0.05 | 0.5 | 10.0 | 12.5 | 305-1 |
| MRF626 | 470 | 0.05 | 0.5 | 10.0 | 12.5 | 305A-1 |
| MRF627 MRF628 | 470 | 0.05 | 0.5 | 10.0 | 12.5 | 249-5 |
| | 470 | 0.25 | 3.0 | 10.8 | 12.5 | TO-39 |
| MRF630 | 870 | 0.063 | 0.5 | 9.0 | 12.5 | 317-1 |
| MRF559 MRF581 | 870 | 0.12 | 1.0 | 9.2 | 12.5 | 317-1 |

TABLE 7. High-Voltage Class C Amplifiers

| Device Type | Frequency (MHz) | P _{in} (w) | P _{out} (w) | G _{pe} dB | Voltage (V) | Case Outline |
|----------------|--------------------|------------------------|-------------------------|-----------------------|----------------|-----------------|
| | 175 | 0.25 | 2.5 | 10.0 | 28.0 | TO-39 |
| 2N3553 | 400 | 0.001 | 0.02 | 13.0 | 26.0 | TO-39 |
| MRF525* | 400 | 0.1 | 1.0 | 10.0 | 28.0 | TO-39 |
| 2N3866 | 400 | 0.16 | 1.0 | 8.0 | 28.0 | TO-39 |
| 2N5160† | | 0.03 | 1.0 | 15.0 | 28.0 | 305A-1 |
| MRF313 | 400 | | | 15.0 | 28.0 | 305-1 |
| MRF313A | 400 | 0.03 | 1.0 | 15.0 | 28.0 | 303 |

*Grounded Emitter TO-39

†PNP

Small-Signal Amplifier Transistor Selection by Package In small-signal RF applications the package style is often determined by the end application, or circuit construction technique. To aid the circuit designer in device selection, below are listed the Motorola broad range of RF small-signal amplifier transistors organized by package. Devices for other applications such as oscillators or switches are shown in the appropriate preceding tables.

TABLE 8. TO-39 METAL CAN

| Gain — BW | | - BW | Noise Figure | | | Gain | | Maximum Ratings | | |
|-------------|-----------|----------|--------------|----------|----------------|-----------|----------|-----------------|----------|----------------|
| Device Type | fT GHz | IC mA | NF dB | f MHz | I _C | dB Min | f MHz | V(BR)CEO | IC mA | P _T |
| MM8000 | 0.7 | 50 | 2.7 | 200 | 10 | 11.4* | 200 | 30 | 0.4 | 3.50 |
| MM8001 | 0.9 | 50 | 2.7 | 200 | 10 | 11.4* | 200 | 30 | 0.4 | 3.50 |
| 2N5109 | 1.2 | 50 | 3.0 | 200 | 10 | 11 | 216 | 20 | 400 | 2.50 |
| 2N5943 | 1.2 | 50 | 3.4 | 200 | 30 | 11.4* | 200 | 30 | 400 | 3.50 |
| MRF525† | 2.5 | 50 | 4.0 | 400 | _ | 13 | 400 | 35** | 150 | 2.50 |
| MRF517 | 2.7 | 60 | 7.5 | 300 | 50 | 10° | 300 | 35** | 150 | 2.50 |
| MRF586 | 4.5 | 70 | 3.0 | 500 | 70 | 14* | 500 | 17 | 200 | 2.50 |

†Grounded Emitter TO-39

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TABLE 9. Plastic — SOE — Case 317-01/317A-01

| | Gain - | — BW | | Noise Figur | 0 | G | ain | Maxim | um Rating | B |
|-------------|-----------|----------|----------|-------------|----------|-----------|----------|------------|-----------|----------------|
| Device Type | fT GHz | IC mA | NF dB | f MHz | IC mA | dB Min | f MHz | V(BR)CEO V | IC mA | P _T |
| MRF931 | 3.0 | 1.0 | 3.8 | 500 | 0.25 | 16* | 500 | 5.0 | 5.0 | 50 |
| MRF559 | 3.0 | 100 | - | _ | | 13.0° | 512 | 18 | 150 | 2000 |
| BFW92A | 4.0 | 25 | 2.5 | 500 | 2.0 | 16* | 500 | 5.0 | 50 | 190 |
| MRF901 | 4.5 | 15 | 2.0 | 1000 | 5.0 | 10 | 1000 | 15 | 30 | 375 |
| BFR96 | 4.5 | . 50 | 2.0* | 500 | 10 | 12 | 500 | 15 | 100 | 500 |
| MRF961 | 4.5 | 50 | 2.0* | 500 | 10 | 13.5 | 500 | 15 | 100 | 500 |
| MRF911 | 5.0 | 30 | 2.5 | 1000 | 5.0 | 12.5* | 1000 | 12 | 40 | 400 |
| BFR90 | 5.0 | 14 | 2.4 | 500 | 2.0 | 18* | 500 | 15 | 30 | 180 |
| BFR91 | 5.0 | 30 | 1.9 | 500 | 2.0 | 16° | 500 | 12 | 35 | 180 |
| MRF571 | 8.0 | 5.0 | 1.0° | 500 | 5.0 | 13.5 | 500 | 10 | 70 | 2500 |
| MRF580 | 5.0 | 75 | 2.0* | 500 | 50.0 | 11.0 | 500 | 18 | 200 | 2500 |
| MRF581 | 5.0 | 75 | 2.0* | 500 | 50.0 | 13.0 | 500 | 18 | 200 | 2500 |
| MRF536** | 5.0 | 20 | 4.5* | 1000 | 3.0 | 8.5 | 1000 | 10 | 30 | 300 |

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TABLE 10. Ceramic — SOE — Case 244A-01, 303-01, 358-01

| | Gain — BW | | | Noise Figure | 9 | Gain | | Maximum Ratings | | |
|-------------|-----------|----------|----------|--------------|-------------------|-----------|----------|-----------------|----------|----------------------|
| Device Type | fT GHz | IC mA | NF dB | f MHz | I _C mA | dB Min | f MHz | V(BR)CEO V | IC mA | P _T mW |
| 2N5947 | 1.5 | 75 | 3.8 | 200 | 50 | 10 | 250 | 30 | 400 | 5000 |
| MRF511 | 2.1 | 80 | 7.3 | 200 | 50 | 10 | 250 | 25 | 250 | 5000 |
| 2N6603 | 4.5 | 15 | 2.0 | 1000 | 5.0 | 13* | 1000 | 15 | 30 | 400 |
| MRF962 | 4.5 | 50 | 2.0* | 500 | 10 | 15 | 500 | 15 | 100 | 750 |
| 2N6604 | 5.0 | 30 | 2.5 | 1000 | 5.0 | 14 | 1000 | 12 | 50 | 500 |
| MRF587 | 5.5 | 70 | 3.0 | 500 | 70 | 15* | 500 | 17 | 200 | 5800 |
| MRF572 | 8.0 | 50 | 2.0 | 1000 | 5.0 | 10 | 1000 | 10 | 70 | 2500 |
| MRF573 | 8.0 | 50 | 2.0 | 1000 | 5.0 | 10 | 1000 | 10 | 70 | 2500 |

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TABLE 11. TO-72 METAL CAN

| | Gain - | – BW | | loise Figure | | Gain | | Maxim | um Ratings | |
|-------------|-----------------------|----------|----------|--------------|----------|-----------|----------|---------------|------------|----------------------|
| Device Type | f _T GHz | lc mA | NF dB | f MHz | IC mA | dB Min | f MHz | V(BR)CEO V | lC mA | P _T mW |
| | | 5.0 | 2.5 | 450 | 1.0 | 14 | 450 | 10 | 20 | 200 |
| 2N5031 | 1.0 | 5.0 | 3.0 | 450 | 1.0 | 14 | 450 | 10 | 20 | 200 |
| 2N5032 | 1.0 | | 3.3 | 450 | 2.0 | 16 | 450 | 30 | 30 | 200 |
| 2N4958° | 1.0 | 2.0 | 3.8 | 450 | 2.0 | 15 | 450 | 30 | 30 | 200 |
| 2N4959° | 1.0 | 2.0 | | 450 | 2.0 | 17 | 450 | 30 | 30 | 200 |
| 2N5829* | 1.2 | 2.0 | 2.5 | | | | | | 30 | 200 |
| 2N4957* | 1.2 | 2.0 | 3.0 | 450 | 2.0 | 17 | 450 | 30 | 50 | 200 |
| MRF501 | 1.2 | 5.0 | 4.0 | 200 | 1.5 | 15** | 200 | 15 | | 200 |
| MRF502 | 1.2 | 5.0 | 4.0 | 200 | 1.5 | 15** | 200 | 15 | 50 | 200 |
| 2N6305 | 1.2 | 10 | 5.5 | 450 | 2.0 | 12 | 450 | 15 | 50 | |
| BFX89 | 1.2 | 25 | 6.5 | 500 | 2.0 | 19 | 200 | 15 | 50 | 200 |
| | | | 5.0 | 500 | 2.0 | 21 | 200 | 15 | 50 | 200 |
| BFY90 | 1.4 | 25 | 4.5 | 200 | 1.5 | 15 | 200 | 12 | 50 | 200 |
| 2N5179 | 1.4 | 10 | | 450 | 2.0 | 15 | 450 | 15 | 50 | 200 |
| 2N6304 | 1.4 | 10 | 4.5 | 450 | 1.5 | 12.5 | 450 | 15 | 40 | 200 |
| 2N3839 | 1.6 | 8.0 | 3.9 | | 1.5 | 12.5 | 450 | 15 | 40 | 200 |
| 2N2857 | 1.6 | 8.0 | 4.1 | 450 | | | | | | 200 |
| MRF904 | 4.0 | 15 | 1.5 | 450 | 5.0 | 16 | 450 | 15 | 30 | |
| MRF914 | 4.5 | 20 | 2.0 | 500 | 5.0 | 15 | 500 | 12 | 40 | 200 |

PNP

RF Amplifier Modules

The devices listed below are general purpose RF hybrid amplifiers, which feature input and output impedance matching and do biasing networks for simplified RF amplifier design.

TABLE 12. General-Purpose 50 Ω — 100 Ω Wideband Modules

| Device Type | Frequency Range MHz | Gain dB Min/Typ | Supply Voltage Vdc | Output Level 1 dB Compression mW/f (MHz) | Noise Figure @ 250 MHz dB |
|-------------|---------------------------|-----------------------|--------------------------|--|---------------------------------|
| | 10-400 | 32.5/34 | 24 | 800/200 | 5.0 |
| MHW590 | + | 35/36.5 | 13.6 | 700/100 | 5.0 |
| MHW591 | 1.0-250 | | 24 | 900/100 | 5.0 |
| MHW592 | 1.0-250 | 34.5/36 | | | 4.5 |
| MHW593 | 10-400 | 34/35.5 | 13.6 | 600/200 | 4.5 |

TABLE 13. TO-39 Wideband, 50 Ω Modules

The MWA Series features excellent gain versus frequency flatness, temperature stability and are cascadable for high gain lineups. Construction techniques include thin film gold metal circuitry and hermetic TO-39 package. MWA devices processed for military applications are available to special order.

| Device Type | Frequency Range MHz | Gain dB Min/Typ | Supply Voltage Vdc | Output Level 1 dB Compression dBm Typ | Noise Figure (400 MHz) dB Typ |
|-------------|---------------------------|-----------------------|--------------------------|---|-------------------------------------|
| MWA110 | 0,1-400 | 13/14 | 2.9 | -2.5 | 4.0 |
| | 0.1-400 | 13/14 | 5.0 | +8.2 | 5.5 |
| MWA120 | | 13/14 | 5.5 | +18 | 7.0 |
| MWA130 | 0.1-400 | | 1.75 | +1.5 | 6.0 |
| MWA210 | 0.1-600 | 9/10 | | | |
| MWA220 | 0.1-600 | 9/10 | 3.2 | + 10.5 | 6.5 |
| MWA230 | 0.1-600 | 9/10 | 4.4 | + 18.5 | 7.5 |
| | | 7/8 | 1.60 | +3.5 | 6.5 |
| MWA310 | 0.1-1000 | | | . 44 5 | 6.7 |
| MWA320 | 0.1-1000 | 7/8 | 2.9 | +11.5 | |
| MWA330 | 0.1-1000 | -/6.2 | 4.0 | + 15.2 | 9.0 |

High Reliability RF Transistors

The listed devices are active per QPL-19500 (Qualified Products List). Check with your local Motorola Sales Office or franchised Distributor for current qualification status and additions.

| 2N2857JAN | 2N4957JAN | |
|--------------|--------------|--|
| 2N2857JTX | 2N4957JTX | |
| 2N2857JTXV | 2N4957JTXV | |
| 2N3553JAN | 2N5109JAN | |
| 2N3553JTX | 2N5109JTX | |
| 2N3553JTXV | 2N5109JTXV | |
| 2N3866JAN | ONICCOO LAN | |
| | 2N6603JAN | |
| 2N3866JTX | 2N6603JTX | |
| 2N3866JTXV | 2N6603JTXV | |
| 2N3866AJAN | 2N6604JAN | |
| 2N3866AJTX | 2N6604JTX | |
| 2N3866AJTXV | 2N6604JTXV | |
| 2112222 1411 | 2.1000-1017. | |
| 2N3960JAN | | |
| 2N3960JTX | | |
| 2N3906JTXV | | |

Transistor Complements

The transistor complements listed are suitable for most applications requiring NPN and PNP devices of similar RF characteristics. If your application demands special matching of complementary transistors, please contact your local Motorola Sales Office or Motorola distributors.

| <u>NPN</u> | PNP |
|----------------|----------------|
| 2N2857 | 2N4958 |
| 2N3553 | MM4019 |
| 2N3866 | 2N5160 |
| 2N3959, 2N3960 | 2N4260, 2N4261 |
| 2N3906JAN | MM4261H |
| 2N5943 | 2N5583 |
| MRF531 | MRF532 |
| MRF904 | MM4049 |
| MRF571 | MRF536 |

PLASTIC ENCAPSULATED SMALL-SIGNAL TRANSISTORS (continued)

Devices for Hi-Rel Applications

Motorola offers over 650 devices listed in QPL-19500, and is certified to supply small-signal bipolar devices to ALL FOUR quality levels of MIL-S-19500: JAN, JANTX, JANTXV, and JANS.

The following tables list the Motorola discrete devices and slash-sheet number as they appear on the Qualified Products List.

Switching and High-Frequency Transistors

| | | 19500 | |
|-------------------------|------|---------------------|---|
| 703 JAN | /153 | 2N3253 JAN | / |
| 706 JAN | /120 | 2N3444 JAN | |
| 708 JAN JTX | /312 | 2N3467 JAN,JTX,JTXV | / |
| 718A JAN JTX JTXV | /181 | 2N3468 JAN,JTX,JTXV | |
| 869A JAN,JTX | /283 | 2N3485A JAN,JTX | |
| 914 JAN,JTX | /373 | 2N3486A JAN,JTX | |
| 916 JAN | /271 | 2N3498 JAN,JTX,JTXV | |
| SIR JAN JIX JIXVJIANS | /301 | 2N3499 JAN,JTX,JTXV | |
| 1929 JAN,JTX | /253 | 2N3500 JAN,JTX,JTXV | I |
| 1930 JAN,JTX | /253 | 2N3501 JAN,JTX,JTXV | |
| 1132 JAN | /177 | 2N3506 JAN,JTX,JTXV | |
| 11132 JAN | /181 | 2N3507 JAN,JTX,JTXV | |
| 11613 JAN,JTX,JTXV | /251 | 2N3634 JAN.JTX.JTXV | |
| 12218 JAN,JTX,JTXV | /251 | 2N3635 JAN,JTX,JTXV | |
| I2219 JAN,JTX,JTXV | /251 | 2N3636 JAN,JTX,JTXV | |
| 12219 JAN,JTX,JTXV | /251 | 2N3637 JAN,JTX,JTXV | |
| IZZ19AL JANS | | 2N3700 JAN,JTX,JTXV | |
| IZZZ19AL JANS | /255 | 2N3735 JAN,JTX,JTXV | |
| 2221 JAN,JIX,JIXV | /255 | 2N3737 JAN,JTX,JTXV | |
| 2221A JAN,JTX,JTXV | /255 | 2N3743 JAN,JTX,JTXV | *************************************** |
| 2222 JAN,JTX,JTXV | /235 | 2N3762 JAN,JTX,JTXV | ************** |
| 2222A JAN,JTX,JTXV,JANS | /217 | 2N3763 JAN,JTX,JTXV | |
| WILLIAM ARACEST | /369 | 2N3764 JAN,JTX,JTXV | |
| 12481 JAN,JTX | /200 | 2N3765 JAN,JTX,JTXV | |
| N2904 JAN,JTX,JTXV | /290 | 2N4033 JAN,JTX,JTXV | |
| N2905 JAN,JTX,JTXV | /200 | 2N4261 JAN,JTX | |
| N2905A JAN,JTX,JTXV | /290 | 2N4405 JAN,JTX | |
| N2905AL JANS | | 2N4449 JAN,JTX,JTXV | |
| N2906 JAN,JTX,JTXV | /291 | 2N4453 JAN,JTX | |
| N2906A JAN,JTX,JTXV | /291 | 2N4930 JAN,JTX,JTXV | |
| N2907 JAN,JTX,JTXV | /291 | 2N4931 JAN,JTX,JTXV | ••••• |
| N2907 JAN,JTX,JTXV,JANS | /291 | 2N5581 JAN,JTX | |
| N2944A JAN,JTX,JTXV | | 2N5582 JAN,JTX | |
| N2945A JAN,JTX,JTXV | | 2N3302 JAN,JIA | *************************************** |
| N2946A JAN,JTX,JTXV | | | |
| N3013 JAN,JTX | /287 | | |
| N3019,S JAN,JTX,JTXV | /391 | | |
| N3250A JAN,JTX,JTXV | /323 | | |
| N3251A JAN,JTX,JTXV | /323 | | |

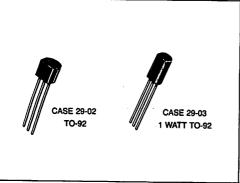
| | MIL-S-1 | 9500 | |
|-------------------------|---------|-----------------------|------|
| 2N918 JAN,JTX,JTXV,JANS | /301 | 2N3959 JAN,JTX,JTXV | /399 |
| 2N2857 JAN,JTX,JTXV | /343 | | /399 |
| 2N3375 JAN,JTX,JTXV | /341 | 2N4957 JAN.JTX.JTXV | /426 |
| 2N3375 JAN,JTX,JTXV | /341 | 2N5109 JAN.JTX.JTXV | |
| 2N3553 JAN,JTX,JTXV | /209 | | |
| 2N3866 JAN,JTX,JTXV | /390 | ONICEDA IAN ITYV | |
| 2N3RRRA JAN JTX JTXV | /3೪೮ | \$14000# \$7414"2 LVA | |

Multiple Devices

| MIL-S-195 | |
|---------------------|------|
| 2N2060 JAN,JTX,JTXV | /270 |
| 2N2919 JAN_JTX_JTXV | /355 |
| 2N2920 JAN,JTX,JTXV | /355 |
| 2N3810 JAN,JTX,JTXV | /336 |
| 2N3811 JAN,JTX,JTXV | /336 |
| 2N4854 JAN,JTX,JTXV | /421 |
| 2N5793 JAN,JTX,JTXV | /49 |
| 2N5794 JAN,JTX,JTXV | /49! |
| 2N5795 JAN,JTX,JTXV | /49 |
| 2N5795 JAN,JIX,JIXV | /AQI |
| 2N5796 JAN,JTX,JTXV | |
| | |

Field-Effect Transistors

| MIL-S-19500 | |
|---------------------|------|
| 2N2608 JAN | /295 |
| 2N2609 JAN | /296 |
| 2N3330 JAN,JTX | /378 |
| 2N3821 JAN,JTX,JTXV | /375 |
| 2N3822 JAN,JTX,JTXV | /375 |
| 2N3823 JAN,JTX,JTXV | /375 |
| 2N4856 JAN,JTX,JTXV | /385 |
| 2N4857 JAN,JTX,JTXV | /385 |
| 2N4858 JAN,JTX,JTXV | /385 |
| 2N4859 JAN,JTX,JTXV | /385 |
| 2N4860 JAN,JTX,JTXV | /385 |
| 2N4861 JAN,JTX,JTXV | /385 |
| 2N4091 JAN,JTX,JTXV | |
| 2N4092 JAN,JTX,JTXV | /431 |
| 2N4093 JAN,JTX,JTXV | /431 |
| | |



Motorola's small-signal TO-92 plastic transistors encompass hundreds of devices spanning the gamut from general-purpose amplifiers and switches with a wide variety of characteristics to dedicated special-purpose devices for the most demanding applications. The popular high-volume TO-92 package combines proven reliability, performance, economy and convenience to provide the perfect solution for industrial and consumer design problems.

As an additional service to our customers Motorola will, upon request, supply the following:

- Radial tape and reel
- · Axial tape and reel
- TO-5 lead forming
- TO-18 lead forming

Contact your Motorola representative for ordering information.

Plastic-Encapsulated Small-Signal Transistors

2N3903 2N3904

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|----------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltge | V _{СВО} | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | Vdc |
| Collector Current — Continuous | Ic | 200 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 2.8 | mW mW/°C |
| *Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | ပ္ |

*THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------|------|
| Thermal Resistance, Junction to Case | RøJC | 83.3 | *C/W |
| Thermal Resistance, Junction to Ambient | RøJA | 200 | °C/W |

^{*}Indicates Data in addition to JEDEC Requirements.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|---|------------------|----------------------|------------|--------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (I _C = 1.0 mAdc, I _B = 0) | | V(BR)CEO | 40 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | | V(BR)CBO | 60 | _ | Vdc |
| Emitter-Base Breakdown Voltage { E = 10 µAdc, C = 0} | | V(BR)EBO | 6.0 | - | Vdc |
| Base Cutoff Current (VCE = 30 Vdc, VEB = 3.0 Vdc) | | IBL | | 50 | nAdc |
| Collector Cutoff.Gurrent (VCE = 30 Vdc, VEB = 3.0 Vdc) | | ICEX | | 50 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(1) (IC = 0.1 mAdc, VCE = 1.0 Vdc) | 2N3903 2N3904 | hFE | 20 40 | = | _ |
| (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) | 2N3903 2N3904 | | 35 70 | = | |
| (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) | 2N3903 2N3904 | | 50 100 | 150 300 | |
| (I _C = 50 mAdc, V _{CE} = 1.0 Vdc) | 2N3903 2N3904 | | 30 60 | = | |
| (I _C = 100 mAdc, V _{CE} = 1.0 Vdc) | 2N3903 2N3904 | | 15 30 | | |
| Collector-Emitter Saturation Voltage(1) (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc) | | VCE(sat) | <u>-</u> | 0.2 0.3 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc) | | V _{BE(sat)} | 0.65 — | 0.85 0.95 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | 1 |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz) | 2N3903 2N3904 | fτ | 250 300 | | MHz |

2N3903, 2N3904

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|--|------------------|------------------|------------|------------|--------|
| Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz) | | Cobo | | 4.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I_C = 0, f = 1.0 MHz) | | C _{ibo} | _ | 8.0 | pF |
| Input Impedance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | 2N3903 2N3904 | h _{ie} | 1.0 1.0 | 8.0 10 | k ohms |
| Voltage Feedback Ratio (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | 2N3903 2N3904 | h _{re} | 0.1 0.5 | 5.0 8.0 | X 10-4 |
| Small-Signal Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | 2N3903 2N3904 | hfe | 50 100 | 200 400 | - |
| Output Admittance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | | h _{oe} | 1.0 | 40 | μmhos |
| Noise Figure (IC = 100 μ Adc, VCE = 5.0 Vdc, RS = 1.0 k ohms, f = 10 Hz to 15.7 kHz) | 2N3903 2N3904 | NF | _ | 6.0 5.0 | dB |

SWITCHING CHARACTERISTICS

| Delay Time | (VCC = 3.0 Vdc, VBE = 0.6 Vdc, | | t _d | _ | 35 | ns |
|--------------|--|------------------|----------------|---|------------|----|
| Rise Time | IC = 10 mAdc, IB1 = 1.0 mAdc) | | t _r | | 35 | ns |
| Storage Time | (VCC = 3.0 Vdc, I _C = 10 mAdc, I _{B1} = I _{B2} = 1.0 mAdc) | 2N3903 2N3904 | ts | _ | 175 200 | пѕ |
| Fall Time | | | tf | | 50 | ns |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

FIGURE 1 - DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT

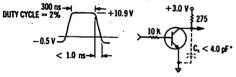
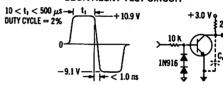
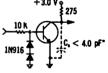


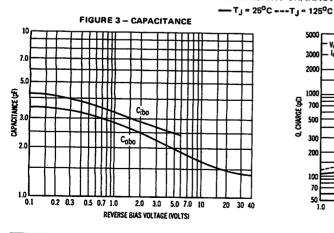
FIGURE 2 - STORAGE AND FALL TIME **EQUIVALENT TEST CIRCUIT**

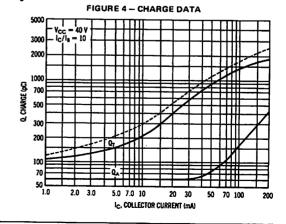


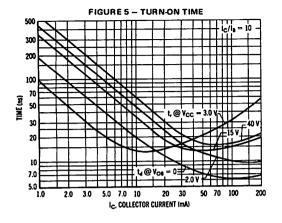


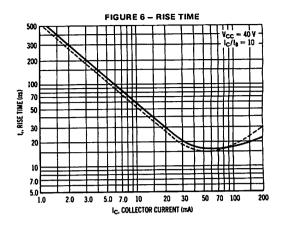
*Total shunt capacitance of test jig and connectors

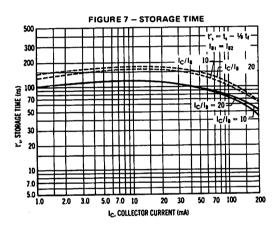
TYPICAL TRANSIENT CHARACTERISTICS

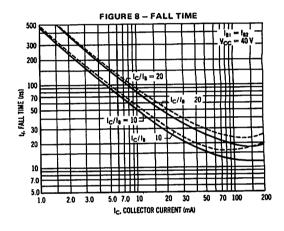




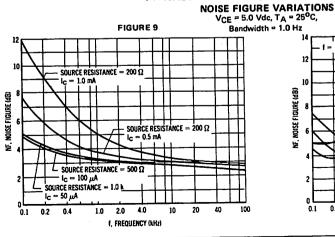


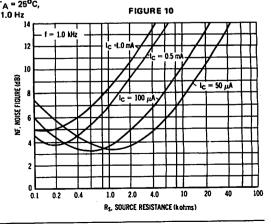






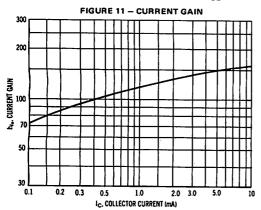
TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS

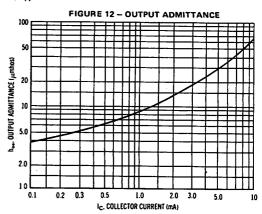


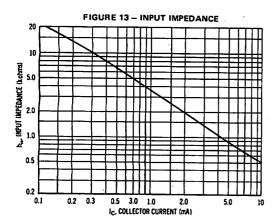


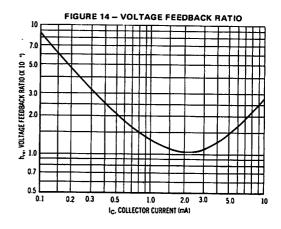
h PARAMETERS

 $(V_{CE} = 10 \text{ Vdc, f} = 1.0 \text{ kHz, T}_{A} = 25^{\circ}\text{C})$

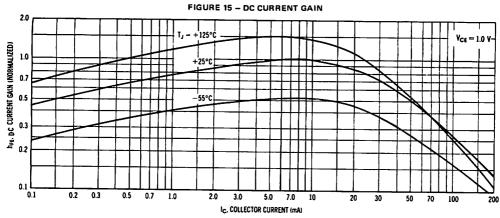


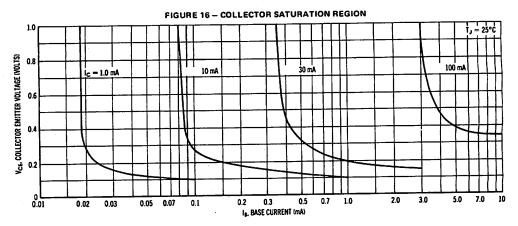


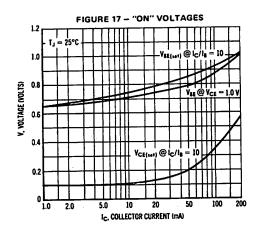


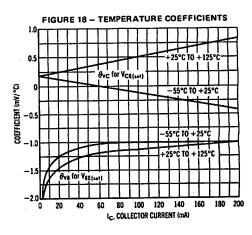


TYPICAL STATIC CHARACTERISTICS









MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 200 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Power Dissipation @ T _A = 60°C | PD | 250 | mW |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

*THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | RøJA | 200 | °C/W |

2N3905 2N3906

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

| Characteristic | | Symbol | Min | Max | Unit |
|---|------------------|----------------------|------------|--------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | | V(BR)CEO | 40 | <u> </u> | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | | V(BR)CBO | 40 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | | V _{(BR)EBO} | 5.0 | _ | Vdc |
| Base Cutoff Current (VCE = 30 Vdc, VBE = 3.0 Vdc) | | IBL | _ | 50 | nAdo |
| Collector Cutoff Current (VCE = 30 Vdc, VBE = 3.0 Vdc) | | ICEX | _ | 50 | nAdo |
| ON CHARACTERISTICS(1) | | | | <u> </u> | |
| DC Current Gain (I _C = 0.1 mAdc, V _{CE} = 1.0 Vdc) | 2N3905 2N3906 | hFE | 30 60 | = | _ |
| (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) | 2N3905 2N3906 | | 40 80 | = | |
| (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) | 2N3905 2N3906 | | 50 100 | 150 300 | |
| (I _C = 50 mAdc, V_{CE} = 1.0 Vdc) | 2N3905 2N3906 | | 30 60 | = | |
| (I _C = 100 mAdc, V _{CE} = 1.0 Vdc) | 2N3905 2N3906 | <u>.</u> | 15 30 | = | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | · | V _{CE(sat)} | = | 0.25 0.4 | Vdc |
| Base-Emitter Saturation Voltage ($I_C=10$ mAdc, $I_B=1.0$ mAdc) ($I_C=50$ mAdc, $I_B=5.0$ mAdc) | | V _{BE(sat)} | 0.65 | 0.85 0.95 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | L |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, V _{CE} = 20 Vdc, f = 100 MHz) | 2N3905 2N3906 | fτ | 200 250 | = | MHz |
| Output Capacitance {VCB = 5.0 Vdc, I _E = 0, f = 100 kHz} | | C _{obo} | | 4.5 | pF |

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|--|------------------|------------------|------------|------------|--------|
| Input Capacitance (VBE = 0.5 Vdc, IC = 0, f = 100 kHz) | | C _{ibo} | _ | 10.0 | pF |
| Input Impedance (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | 2N3905 2N3906 | h _{ie} | 0.5 2.0 | 8.0 12 | k ohms |
| Voltage Feedback Ratio (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | 2N3905 2N3906 | h _{re} | 0.1 0.1 | 5.0 10 | X 10-4 |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | 2N3905 2N3906 | h _{fe} | 50 100 | 200 400 | _ |
| Output Admittance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | 2N3905 2N3906 | h _{oe} | 1.0 3.0 | 40 60 | μmhos |
| Noise Figure (I _C = 100 µAdc, V _{CE} = 5.0 Vdc, R _S = 1.0 k ohm, f = 10 Hz to 15.7 kHz) | 2N3905 2N3906 | NF | = | 5.0 4.0 | dB |

SWITCHING CHARACTERISTICS

| Delay Time | (VCC = 3.0 Vdc, VBE = 0.5 Vdc | | td | - | 35 | ns |
|--------------|-------------------------------|------------------|----|---|------------|----|
| Rise Time | IC = 10 mAdc, IB1 = 1.0 mAdc) | | tr | _ | 35 | ns |
| Storage Time | (VCC = 3.0 Vdc, IC = 10 mAdc, | 2N3905 2N3906 | ts | _ | 200 225 | ns |
| Fall Time | | 2N3905 2N3906 | tf | _ | 60 75 | ns |

⁽¹⁾ Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

FIGURE 1 — DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT

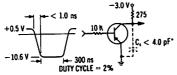
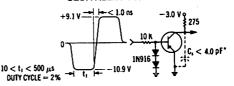
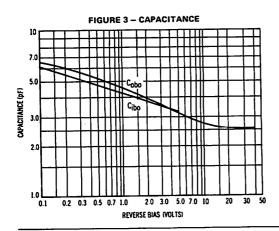


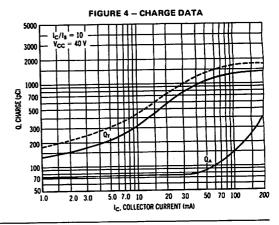
FIGURE 2 - STORAGE AND FALL TIME EQUIVALENT TEST CIRCUIT

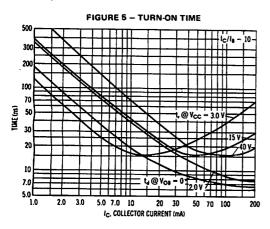


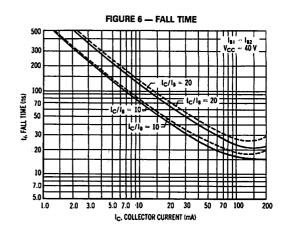
*Total shunt capacitance of test jig and connectors

TRANSIENT CHARACTERISTICS ____ T_J = 25°C --- T_J = 125°C



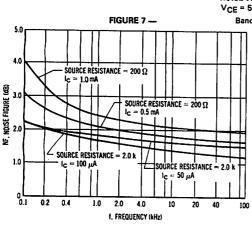


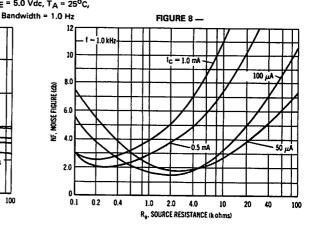




AUDIO SMALL SIGNAL CHARACTERISTICS

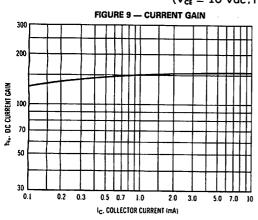
NOISE FIGURE VARIATIONS VCE = 5.0 Vdc, T_A = 25°C,

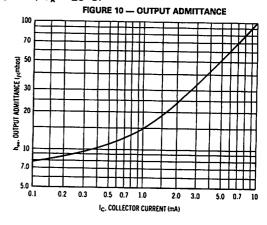




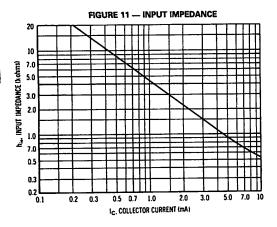
h PARAMETERS

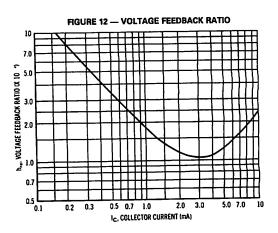
 $(V_{CE} = 10 \text{ Vdc.f} = 1.0 \text{ kHz}, T_A = 25^{\circ}\text{C})$



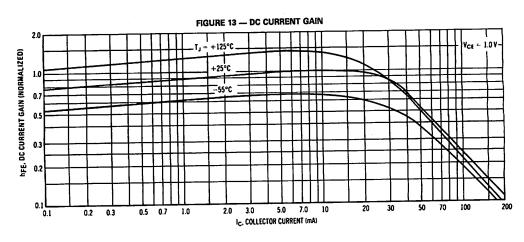


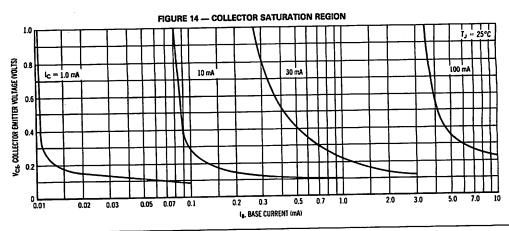
2N3905, 2N3906

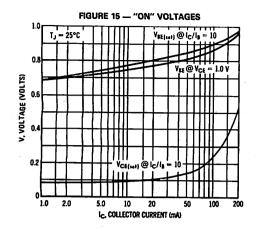


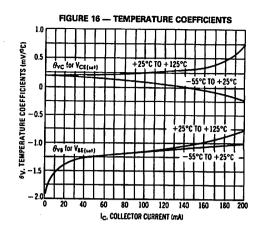


STATIC CHARACTERISTICS









2N4123 2N4124

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | 2N4123 | 2N4124 | Unit |
|--|-----------------------------------|------------|--------|---------------|
| Collector-Emitter Voltage | VCEO | 30 | 25 | Vdc |
| Collector-Base Voltage | Vcво | 40 | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 5 | .0 | Vdc |
| Collector Current — Continuous | lc | 200 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 2.8 | | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 8.0 | | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 55 t | 0 +150 | ℃ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------|------|
| Thermal Resistance, Junction to Case | ReJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | RøJA | 200 | °C/W |

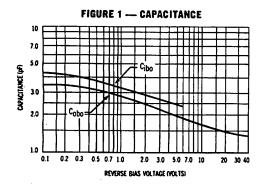
| ELECTRICAL CHARACTERISTICS (T _A = 25°C unless Characteristic | | Symbol | Min | Max | Unit |
|--|------------------|----------------------|------------|------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, I _E = 0) | 2N4123 2N4124 | V(BR)CEO | 30 25 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | 2N4123 2N4124 | V(BR)CBO | 40 30 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 20 Vdc, IE = 0) | | ICBO | | 50 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | | IEBO | | 50 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(1) (IC = 2.0 mAdc, VCE = 1.0 Vdc) | 2N4123 2N4124 | hFE | 50 120 | 150 360 | _ |
| (IC = 50 mAdc, V_{CE} = 1.0 Vdc) | 2N4123 2N4124 | | 25 60 | | |
| Collector-Emitter Saturation Voltage(1) (IC = 50 mAdc, Ig = 5.0 mAdc) | | VCE(sat) | _ | 0.3 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 50 mAdc, IB = 5.0 mAdc) | | V _{BE(sat)} | | 0.95 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | 1 |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz) | 2N4123 2N4124 | fτ | 250 300 | | MHz |
| Output Capacitance (VCB = 5.0 Vdc, IE = 0, f = 100 MHz) | | C _{obo} | | 4.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = 0, f = 100 kHz) | | C _{ibo} | | 8.0 | pF |
| Collector-Base Capacitance (IE = 0, VCB = 5.0 V, f = 100 kHz) | | C _{cb} | _ | 4.0 | pF |
| Small-Signal Current Gain (IC = 2.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | 2N4123 2N4124 | h _{fe} | 50 120 | 200 480 | _ |

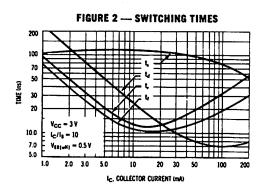
2N4123, 2N4124

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|---|--------|-----------------|-----|-----|------|
| Current Gain — High Frequency | | h _{fe} | | | _ |
| $(I_C = 10 \text{ mAdc}, V_{CE} = 20 \text{ Vdc}, f = 100 \text{ MHz})$ | 2N4123 | ' '' | 2.5 | _ | l |
| | 2N4124 | | 3.0 | - | |
| $(I_C = 2.0 \text{ mAdc}, V_{CE} = 10 \text{ V}, f = 1.0 \text{ kHz})$ | 2N4123 | | 50 | 200 | |
| $(I_C = 2.0 \text{ mAdc}, V_{CE} = 10 \text{ V}, f = 1.0 \text{ kHz})$ | 2N4124 | | 120 | 480 | 1 |
| Noise Figure | | NF | | | dB |
| (IC = 100 μ Adc, VCE = 5.0 Vdc, Rs = 1.0 kohm, | 2N4123 | | _ | 6.0 | } |
| Noise Bandwidth = 10 Hz to 15.7 kHz) | 2N4124 | | _ | 5.0 | ł |

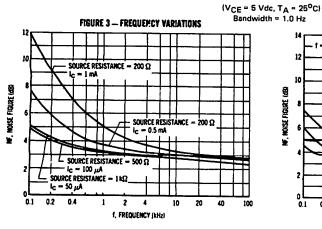
⁽¹⁾ Pulse Test: Pulse Width = 300 μ s, Duty Cycle = 2.0%.

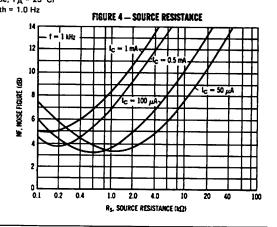




AUDIO SMALL SIGNAL CHARACTERISTICS

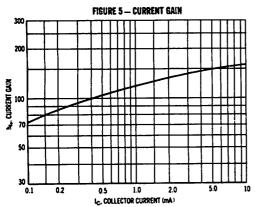
NOISE FIGURE

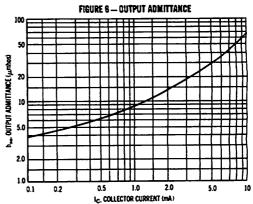


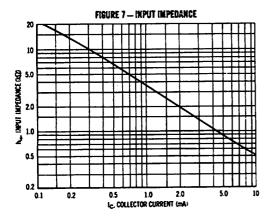


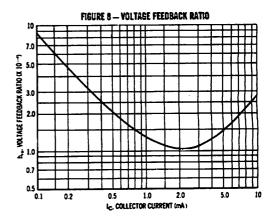
h PARAMETERS

 $V_{CE} = 10 \text{ V, f} = 1 \text{ kHz, } T_A = 25^{\circ}\text{C}$

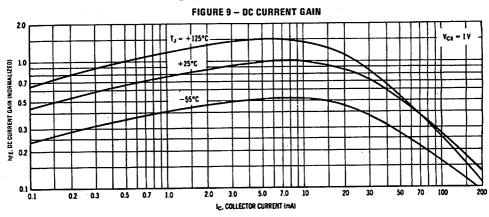


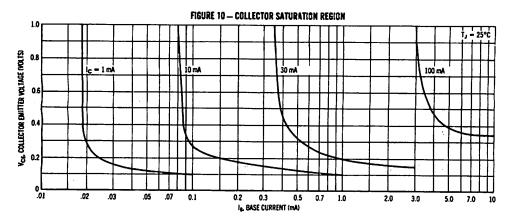


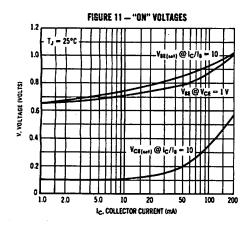


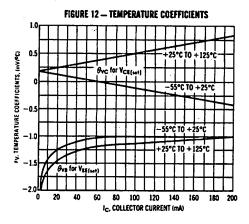


STATIC CHARACTERISTICS









2N4125 2N4126

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | 2N4125 | 2N4126 | Unit |
|---|-----------------------------------|-------------|--------|---------------|
| Collector-Emitter Voltage | VCEO | 30 | 25 | Vdc |
| Collector-Base Voltage | V _{CBO} | 30 | 25 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | | Vdc |
| Collector Current — Continuous | lc | 2 | 200 | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12.0 | | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 55 to | ~c | |

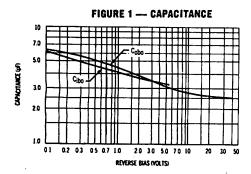
THERMAL CHARACTERISTICS

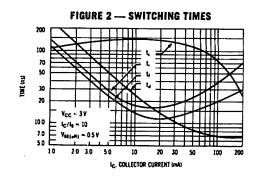
| Characteristic | Symbol | Max | Unit . |
|---|--------|------|--------|
| Thermal Resistance, Junction to Case | ReJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | RAJA | 200 | °C/W |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|---|----------------------------|----------------------|-----------------|-----------------|-------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IE = 0 | 2N4125 2N4126 | V(BR)CEO | 30 25 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | 2N4125 2N4126 | V(BR)CBO | 30 25 | | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | | V(BR)EBO | 4.0 | | Vdc |
| Collector Cutoff Current (VCB = 20 Vdc, IE = 0) | | ICBO | | 50 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | | !EBO | | 50 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(1) (IC = 2.0 mAdc, V _{CE} = 1.0 Vdc) (IC = 50 mAdc, V _{CE} = 1.0 Vdc) | 2N4125 2N4126 2N4125 | hFE | 50 120 25 | 150 360 — | _ |
| | 2N4126 | | 60 | | |
| Collector-Emitter Saturation Voltage(1) {IC = 50 mAdc, Ig = 5.0 mAdc) | | V _{CE(sat)} | | 0.4 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 50 mAdc, IB = 5.0 mAdc) | | V _{BE(sat)} | _ | 0.95 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz) | 2N4125 2N4126 | fr | 200 250 | | MHz |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | | C _{ibo} | _ | 10 | pF |
| Collector-Base Capacitance (VCB = 5.0 Vdc, IE = 0, f = 1.0 MHz) | | C _{cb} | | 4.5 | pF |
| Small-Signal Current Gain (IC = 2.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | 2N4125 2N4126 | h _{fe} | 50 120 | 200 480 | _ |
| Current Gain — High Frequency (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz) | 2N4125 2N4126 | h _{fe} | 2.0 2.5 | = | |
| Noise Figure (IC = 100 μ Adc, VCE = 5.0 Vdc, RG = 1.0 k ohm, Noise Bandwidth = 10 Hz to 15.7 kHz) | 2N4125 2N4126 | NF | | 5.0 4.0 | dB |

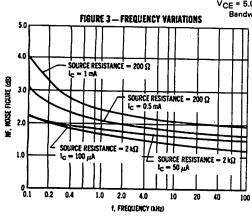
(1) Pulse Test: Pulse Width ≤ 300 µsec, Duty Cycle = 2.0%.

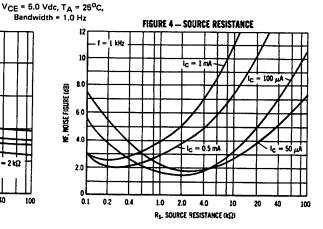




AUDIO SMALL SIGNAL CHARACTERISTICS

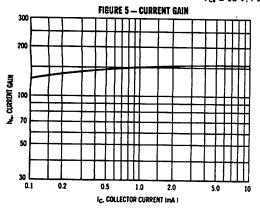


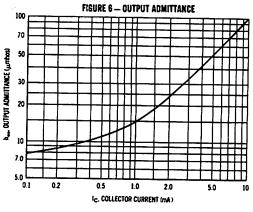


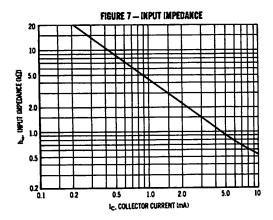


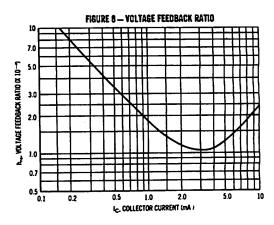
h PARAMETERS

Vct = 10 V, f = 1 kHz, TA = 25°C

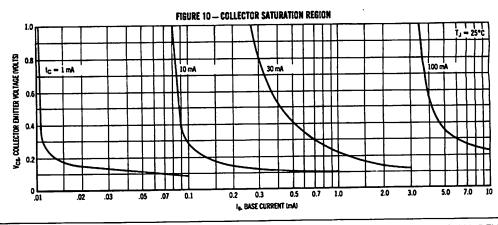


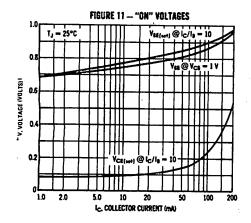


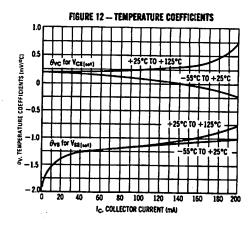




STATIC CHARACTERISTICS FIGURE 9 - DC CURRENT GAIN 2.0 +125°C = رT +25°C hFE, DC CURRENT GAIN (NORMALIZED) -55°C 0.7 0.5 0.2 0.1 50 7.0 0.7 3.0 0.2 0.3 Ic. COLLECTOR CURRENT (mA)







2N4264 2N4265

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

THERMAL CHARACTERISTICS

| Characteristic | Symbol | 2N4264 | 2N4265 | Unit | | |
|---|-----------------------------------|-------------|------------|-------|--|----------------|
| Collector-Emitter Voltage | VCEO | 15 | 12 | Vdc | | |
| Collector-Base Voltage | VCBO | 3 | 30 V | | | |
| Emitter-Base Voltage | VEBO | 6.0 | | 6.0 V | | Vdc |
| Collector Current — Continuous | lc | 200 | | mAdc | | |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | | 625 5.0 | | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | | 1 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | | °C | | |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|-------------------|------|------|
| Thermal Resistance, Junction to Case | R _Ø JC | 83.3 | •c\M |
| Thermal Resistance, Junction to Ambient | R _Ø JA | 200 | °C/W |

Unit **Symbol** Min Max Characteristic OFF CHARACTERISTICS Vdc V(BR)CEO Collector-Emitter Breakdown Voltage 15 2N4264 $(I_C = 1.0 \text{ mAdc}, I_E = 0)$ 12 2N4265 20 Vdc V(BR)CBO Collector-Base Breakdown Voltage (I_C = 10 μ Adc, I_E = 0) Vdc 6.0 V(BR)EBO Emitter-Base Breakdown Voltage $(l_E = 10 \,\mu\text{Adc}, \, l_C = 0)$ μAdc BEV **Base Cutoff Current** 0.1 $(V_{CE} = 12 \text{ Vdc}, V_{EB(off)} = 0.25 \text{ Vdc})$ 10 (VCE = 12 Vdc, VEB(off) = 0.25 Vdc, TA = 100°C) 100 nAdc CEX **Collector Cutoff Current** $(V_{CE} = 12 \text{ Vdc}, V_{EB(off)} = 0.25 \text{ Vdc})$ ON CHARACTERISTICS hFE DC Current Gain 2N4264 25 (IC = 1.0 mAdc, VCE = 1.0 Vdc) 2N4265 30 2N4264 40 160 $(I_C = 10 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc})$ 400 100 2N4265 20 2N4264 (I_C = 10 mAdc, V_{CE} = 1.0 Vdc, T_A = -55°C) 2N4265 45 40 2N4264 $(I_C = 30 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc})$ 2N4265 90

(IC = 100 mAdc, VCE = 1.0 Vdc)(1)

(IC = 200 mAdc, VCE = 1.0 Vdc)(1)

Collector-Emitter Saturation Voltage

(IC = 10 mAdc, IB = 1.0 mAdc)

(IC = 10 mAdc, IB = 1.0 mAdc)

Base-Emitter Saturation Voltage

(IC = 100 mAdc, IB = 10 mAdc)(1)

(IC = 100 mAdc, IB = 10 mAdc)(1)

0.22

0.35

0.80

0.95

Vdc

Vdc

30

55

20

35

0.65

VCE(sat)

V_{BE(sat)}

2N4264

2N4265

2N4264

2N4265

2N4264, 2N4265

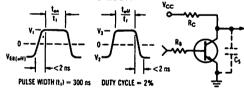
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

| | Characteristic | Symbol | Min | Max | Unit |
|---|---|------------------|-----|------|------|
| SMALL-SIGNAL CHAR | ACTERISTICS | | | | |
| Current-Gain — Bandwi (IC = 10 mAdc, VCE | idth Product = 10 Vdc, f = 100 MHz) | fτ | 350 | _ | MHz |
| Input Capacitance (VBE = 0.5 Vdc, IC = | 0, f = 1.0 MHz) | C _{ibo} | _ | 8.0 | pF |
| Collector-Base Capacitance (VCB = 5.0 Vdc, IE = 0, f = 1.0 MHz) | | C _{cb} | | 4.0 | pF |
| SWITCHING CHARACT | ERISTICS | | | | |
| Delay Time | (VCC = 10 Vdc, VEB(off) = 2.0 Vdc, | td | | 8.0 | ns |
| Rise Time | IC = 100 mAdc, IB1 = 10 mAdc) (Fig. 1, Test Condition C) | tr | | 15 | ns |
| Storage Time | VCC = 10 Vdc, (IC = 10 mAdc, for t ₈) | ts | _ | 20 | ns |
| Fall Time | (I _C = 100 mA for t _f) I _{B1} = I _{B2} = 10 mAdc) (Fig. 1, Test Condition C) | tf | _ | . 15 | ns |
| Turn-On Time | (V _{CC} = 3.0 Vdc, V _{EB(off)} = 1.5 Vdc, I _C = 10 mAdc, I _{B1} = 3.0 mAdc) (Fig. 1, Test Condition A) | ton | - | 25 | ns |
| Turn-Off Time | (VCC = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = 3.0 mAdc, I_{B2} = 1.5 mAdc) (Fig. 1, Test Condition A) | ^t off | _ | 35 | ns |
| Storage Time | (V _{CC} = 10 Vdc, I _C = 10 mA I _{B1} = I _{B2} = 10 mAdc) (Fig. 1, Test Condition A) | ts | | 20 | ns |
| Total Control Charge | (V _{CC} = 3.0 Vdc, I _C = 10 mAdc, I _B = mAdc) (Fig. 1, Test Condition B) | Ωт | _ | 80 | рС |

⁽¹⁾ Pulse Test: Pulse Width = 300 µs, Duty Cycle = 2.0%.

FIGURE 1 — SWITCHING TIME EQUIVALENT TEST CIRCUIT

| TEST CONDITION | k | Vcc | Ra | Rc | Csimes | A ^{ES(ott)} | ٧, | V, | ٧, |
|-------------------|-----|-----|------|-----|--------|----------------------|-------|-------|-------|
| L | mA | ٧ | Ω | Ω | ₽F | V | ٧ | ٧ | V |
| A | 10 | 3 | 3300 | 270 | 4 | -1.5 | 10.55 | -4.15 | 10.70 |
| | 10 | 10 | 560 | 960 | 4 | | - | -4.65 | 6.55 |
| C | 100 | 10 | 560 | 96 | 12 | -2.0 | 6.35 | -4.65 | 6.55 |



CURRENT GAIN CHARACTERISTICS

FIGURE 2 - MINIMUM CURRENT GAIN

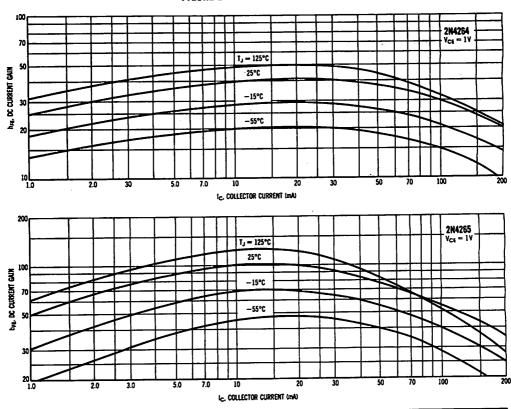
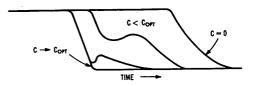


FIGURE 3 - QT TEST CIRCUIT

+10V $\frac{t_1}{\Delta V}$ $\frac{3V}{0}$ $\frac{270}{\Omega}$ $\frac{\Omega}{8 \text{ pF}}$ $\frac{1}{C_S} < 4 \text{ pF}$ PULSE WIDTH $(t_1) = 5 \text{ } \mu \text{ S}$ DUITY CYCLE = 2%

FIGURE 4 - TURN-OFF WAVEFORM



NOTE 1

When a transistor is held in a conductive state by a base current, I_a , a charge, Q_a , is developed or "stored" in the transistor, Q_a may be written: $Q_a = Q_1 + Q_2 + Q_3$. Q_1 is the charge required to develop the required collector current.

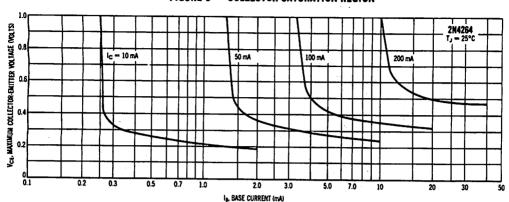
 Q_t is the charge required to develop the required collector current. This charge is primarily a function of alpha cutoff frequency, Q_t is the charge required to charge the collector-base feedback capacity. Q_x is excess charge resulting from overdrive, i.e., operation in saturation.

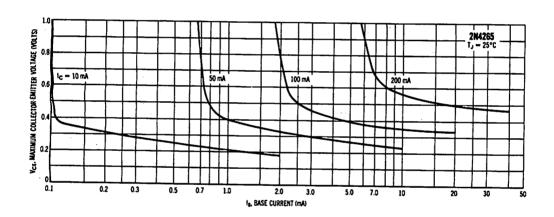
The charge required to turn a transistor "on" to the edge of saturation is the sum of Q_1 and Q_2 which is defined as the active region charge, Q_A . $Q_A = I_{B1}t$, when the transistor is driven by a constant current step (I_{B1}) and $I_{B1} < < \frac{l_C}{h_B}$.

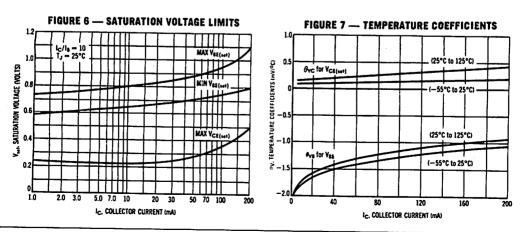
If I, were suddenly removed, the transistor would continue to conduct until Q, is removed from the active regions through an external path or through internal recombination. Since the internal recombination time is long compared to the ultimate capability of a transistor, a charge, Q₁, of opposite polarity, equal in magnitude, can be stored on an external capacitor, C, to neutralize the internal charge and considerably reduce the turn-off time of the transistor. Figure 3 shows the test circuit and Figure 4 the turn-off waveform. Given Q₁ from Figure 13, the external C for worst-case turn-off in any circuit is: $C = Q_1/\Delta V$, where ΔV is defined in Figure 3.

"ON" CONDITION CHARACTERISTICS

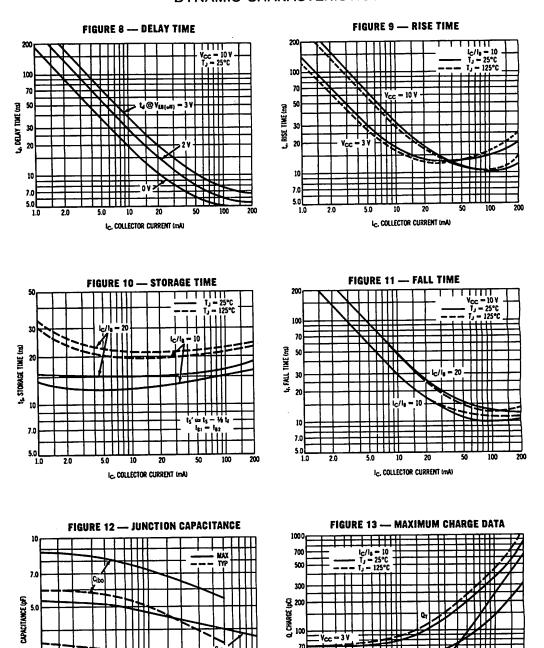
FIGURE 5 — COLLECTOR SATURATION REGION







DYNAMIC CHARACTERISTICS



0.5

REVERSE BIAS (Vdc)

3.0

2.0

5.0

3.0

2.0

50 70 10

Ic. COLLECTOR CURRENT (mA)

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|----------------------|-------------|---------------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | Vdc |
| Collector Current — Continuous | IC. | 600 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 200 | °C/W |

2N4400 2N4401

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|--|------------------|----------------------|------------|-------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | | V(BR)CEO | 40 | T - | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.1 mAdc, IE = 0) | | V(BR)CBO | 60 | T - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 0.1 mAdc, I _C = 0) | | V(BR)EBO | 6.0 | - | Vdc |
| Base Cutoff Current (VCE = 35 Vdc, VEB = 0.4 Vdc) | | BEV | | 0.1 | μAdc |
| Collector Cutoff Current (VCE = 35 Vdc, VEB = 0.4 Vdc) | | []] CEX | _ | 0.1 | μAdc |
| ON CHARACTERISTICS(1) | | | | <u> </u> | L |
| DC Current Gain (IC = 0.1 mAdc, V _{CE} = 1.0 Vdc) | 2N4401 | hFE | 20 | | T - |
| (I _C = 1.0 mAdc, V_{CE} = 1.0 Vdc) | 2N4400 2N4401 | | 20 40 | _ | |
| (IC = 10 mAdc, VCE = 1.0 Vdc) | 2N4400 2N4401 | | 40 80 | _ | |
| (I _C = 150 mAdc, V _{CE} = 1.0 Vdc) | 2N4400 2N4401 | | 50 100 | 150 300 | |
| (I _C = 500 mAdc, V _{CE} = 2.0 Vdc) | 2N4400 2N4401 | | 20 40 | _ | |
| Collector-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) (IC = 500 mAdc, IB = 50 mAdc) | | V _{CE(sat)} | | 0.4 0.75 | Vdc |
| Base-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) (IC = 500 mAdc, IB = 50 mAdc) | | V _{BE(sat)} | 0.75 | 0.95 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 20 mAdc, VCE = 10 Vdc, f = 100 MHz), | 2N4400 2N4401 | fΤ | 200 250 | _ | MHz |
| Collector-Base Capacitance (VCB = 5.0 Vdc, IE = 0, f = 100 kHz) | | C _{cb} | _ | 6.5 | ρF |

2N4400, 2N4401

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

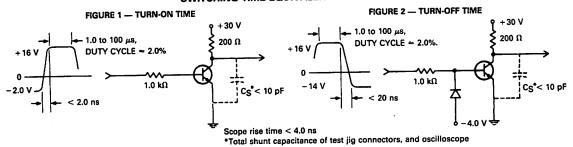
| Characteristic | | Symbol | Min | Max | Unit |
|--|------------------|-----------------|------------|------------|--------|
| Emitter-Base Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 100 kHz) | | C _{eb} | _ | 30 | pF |
| Input Impedance (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | 2N4400 2N4401 | h _{ie} | 0.5 1.0 | 7.5 15 | k ohms |
| Voltage Feedback Ratio (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | | h _{re} | 0.1 | 8.0 | X 10-4 |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | 2N4400 2N4401 | h _{fe} | 20 40 | 250 500 | _ |
| Output Admittance (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | | h _{oe} | 1.0 | 30 | μmhos |

SWITCHING CHARACTERISTICS

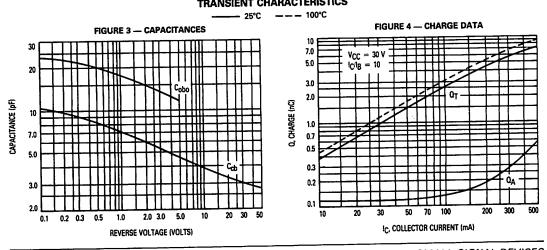
| Delay Time | (V _{CC} = 30 Vdc, V _{EB} = 2.0 Vdc, | td | - | 15 | ns |
|------------|---|----|----------|-----|----|
| Rise Time | IC = 150 mAdc, IB1 = 15 mAdc) | tr | _ | 20 | ns |
| | (VCC = 30 Vdc, IC = 150 mAdc, | ts | | 225 | ns |
| Soll Time | IB1 = IB2 = 15 mAdc) | tf | _ | 30 | ns |

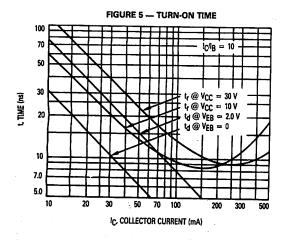
⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

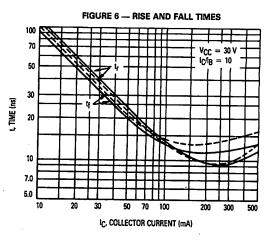
SWITCHING TIME EQUIVALENT TEST CIRCUITS

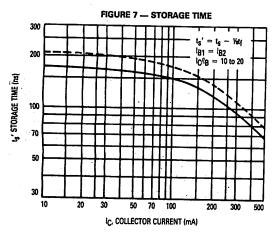


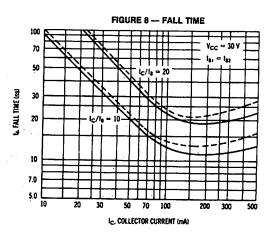
TRANSIENT CHARACTERISTICS



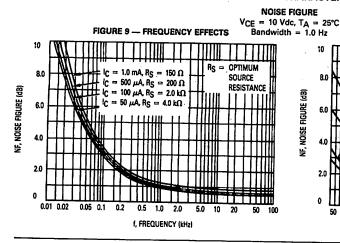


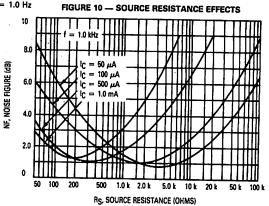






SMALL-SIGNAL CHARACTERISTICS





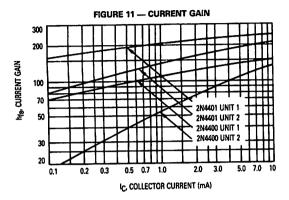
SMALL-SIGNAL DEVICES

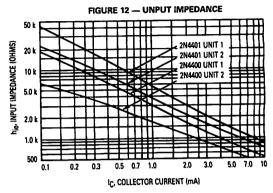
MOTOROLA SEMICONDUCTORS

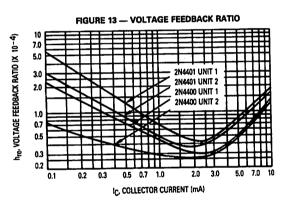
h PARAMETERS

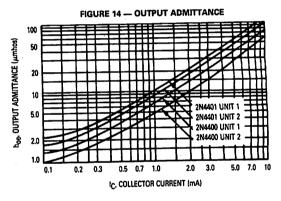
VCE = 10 Vdc, f = 1.0 kHz, TA = 25°C

This group of graphs illustrates the relationship between hfo and other "h" parameters for this series of transistors. To obtain these curves, a high-gain and a low-gain unit were selected from both the 2N4400 and 2N4401 lines, and the same units were used to develop the correspondingly numbered curves on each graph.

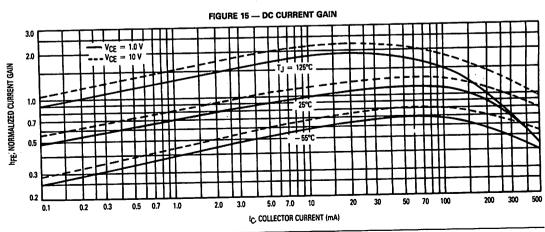


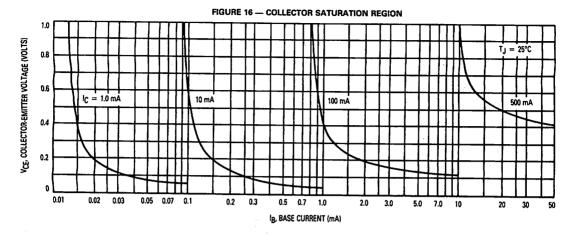


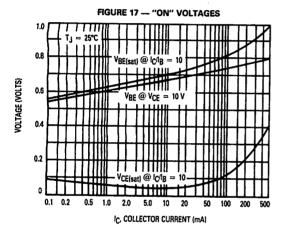


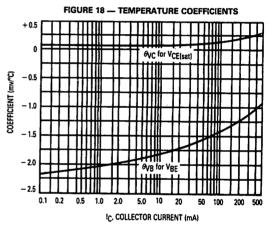


STATIC CHARACTERISTICS









2N4402 2N4403

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Reting | Symbol | Value | Unit |
|--|-----------------------------------|-------------|---------------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 40 | Vdc |
| Emitter-Base Voltage | V _{EBO} | 5.0 | Vdc |
| Collector Current — Continuous | lc | 600 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | ů |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Case | RAJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 200 | •cw |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|---|------------------|-----------------------|-------------|-------------|----------|
| OFF CHARACTERISTICS | | · | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAd | c, IB = 0) | V(BR)CEO | 40 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.1 mAdc, IE | | V(BR)CBO | 40 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 0.1 mAdc, I _C = | | V(BR)EBO | 5.0 | | Vdc |
| Base Cutoff Current (VCE = 35 Vdc, VBE = 0.4 Vdc) | | IBEV | | 0.1 | μAdc |
| Collector Cutoff Current (VCE = 35 Vdc, VBE = 0.4 Vd | c) | ICEX | | 0.1 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 0.1 mAdc, VCE = 1.0 Vdc) | 2N4403 | hFE | 30 | _ | – |
| (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) | 2N4402 2N4403 | | 30 60 | = | |
| (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) | 2N4402 2N4403 | | 50 100 | = | |
| (I _C = 150 mAdc, V _{CE} = 2.0 Vdc)(1) | 2N4402 2N4403 | | 50 100 | 150 300 | |
| (IC = 500 mAdc, VCE = 2.0 Vdc)(1) | Both | | 20 | | |
| Collector-Emitter Saturation Voltage(1) (IC = 150 mAdc, IB = 15 mAdc) (IC = 500 mAdc, IB = 50 mAdc) | | VCE(sat) | | 0.4 0.75 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 150 mAdc, IB = 15 mAdc) (IC = 500 mAdc, IB = 50 mAdc) | | V _{BE} (sat) | 0.75 — | 0.95 1.3 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | т | 1 2011- |
| Current-Gain — Bandwidth Product (IC = 20 mAdc, VCE = 10 Vdc, f = 100 MHz) | 2N4402 2N4403 | fτ | 150 200 | | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, I _E = 0, f = 140 kHz) | | C _{cb} | _ | 8.5 | pF |
| Emitter-Base Capacitance (VBE = 0.5 Vdc, IC = 0, f = 140 kHz) | | C _{eb} | | 30 | pF |
| Input Impedance (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | 2N4402 2N4403 | h _{ie} | 750 1.5k | 7.5k 15k | ohms |

2N4402, 2N4403

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

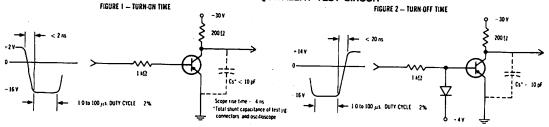
| Characteristic | Symbol | Min | Max | Unit |
|---|-----------------|----------|------------|--------|
| Voltage Feedback Ratio (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{re} | 0.1 | 8.0 | X 10-4 |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) 2N4402 2N4403 | h _{fe} | 30 60 | 250 500 | _ |
| Output Admittance (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | hoe | 1.0 | 100 | μmhos |

SWITCHING CHARACTERISTICS

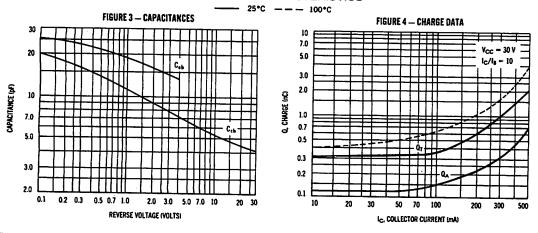
| Delay Time | (V _{CC} = 30 Vdc, V _{BE} = 2.0 Vdc, | ^t d | | 15 | ns |
|--------------|---|----------------------|---|-----|----|
| Rise Time | IC = 150 mAdc, IB1 = 15 mAdc) | · t _r | _ | 20 | ns |
| Storage Time | (VCC = 30 Vdc, IC = 150 mAdc, | ts | | 225 | ns |
| Fall Time | l _{B1} = l _{B2} = 15 mAdc) | tf | | 30 | ns |

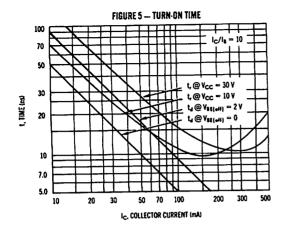
(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

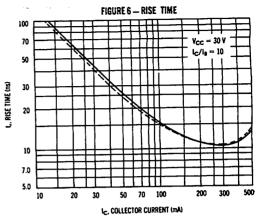
SWITCHING TIME EQUIVALENT TEST CIRCUIT

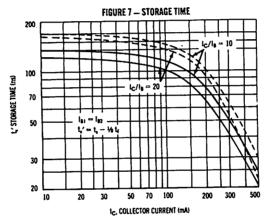


TRANSIENT CHARACTERISTICS

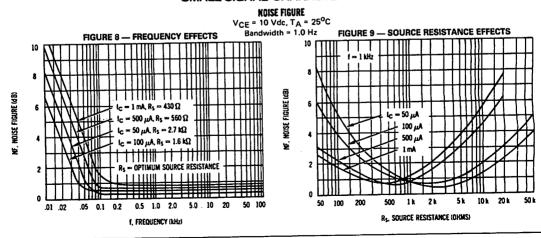








SMALL-SIGNAL CHARACTERISTICS

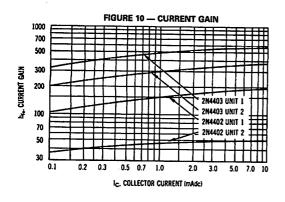


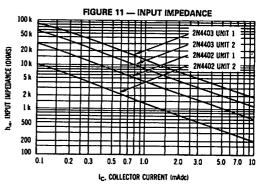
h PARAMETERS

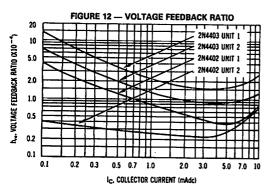
Vcs = 10 Vdc, f = 1 kHz, TA = 25°C

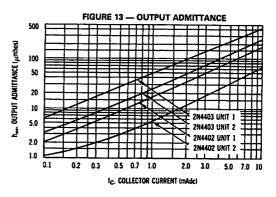
This group of graphs illustrates the relationship between h_{is} and other "h" parameters for this series of transistors. To obtain these curves, a high-gain and a low-gain unit were selected from both the

2N4402 and 2N4403 lines, and the same units were used to develop the correspondingly-numbered curves on each graph.

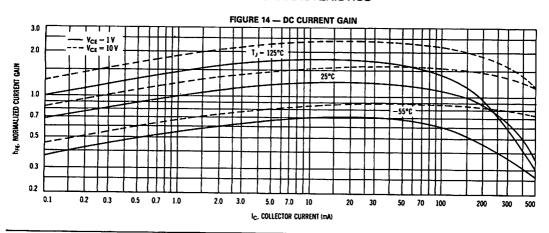


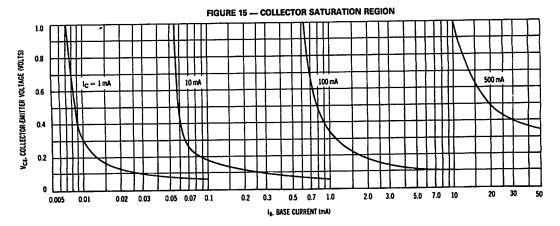


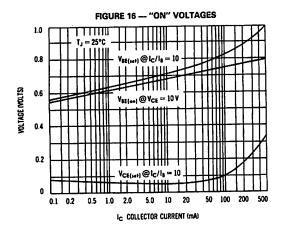


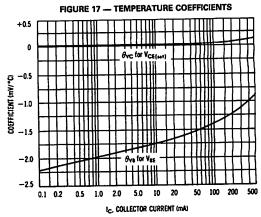


STATIC CHARACTERISTICS









MAXIMUM RATINGS

| Rating | Symbol | 2N4409 | 2N4410 | Unit | | |
|---|------------------|------------|--------|----------------|--|------|
| Collector-Emitter Voltage | VCEO | 50 | 80 | Vdc | | |
| Collector-Base Voltage | V _{CBO} | 80 | 120 | Vdc | | |
| Emitter-Base Voltage | VEBO | 5.0 | | 5.0 | | Vdc |
| Collector Current — Continuous | ¹c | 250 | | 250 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | | mW mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | | Watts mW/°C | | |
| Operating and Storage Junction Temperature Range | TJ, Tstg | -65 to | +200 | °C | | |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------|------|
| Thermal Resistance, Junction to Case | RøJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | RAIA | 200 | °C/W |

2N4409 2N4410

CASE 29-02, STYLE 1 TO-92 (TO-226AA) AMPLIFIER TRANSISTOR

Refer to 2N5550 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|-----------|----------------------------|------|
| OFF CHARACTERISTICS | | | | 1 |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) 2N4409 2N4410 | V(BR)CEO | 50 80 | = | Vdc |
| Collector-Emitter Breakdown Voltage (I _C = 500 μAdc, V _{BE} = 5.0 Vdc, R _{BE} = 8.2 kohms) 2N4409 2N4410 | V(BR)CEX | 80 120 | = | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 μAdc, IE = 0) 2N4409 2N4410 | V(BR)CBO | 80 120 | = | Vdc |
| Emitter-Base Breakdown Voltage (Ig = 10 μAdc, I _C = 0) | V(BR)EBO | 5.0 | | Vdc |
| Collector Cutoff Current (VCB = 60 Vdc, IE = 0) (VCB = 60 Vdc, IE = 0, T _A = 100°C) (VCB = 100 Vdc, IE = 0) (VCB = 100 Vdc, IE = 0, T _A = 100°C) 2N4410 (VCB = 100 Vdc, IE = 0, T _A = 100°C) 2N4410 | ІСВО | | 0.01 1.0 0.01 1.0 | μAdc |
| Emitter Cutoff Current (VBE = 4.0 Vdc, I _C = 0) | IEBO | _ | 0.1 | μAdc |
| ON CHARACTERISTICS | | | · | |
| DC Current Gain (IC = 1.0 mAdc, VCE = 1.0 Vdc) (IC = 10 mAdc, VCE = 1.0 Vdc) | hFE | 60 60 | 400 | _ |
| Collector-Emitter Saturation Voltage (IC = 1.0 mAdc, IB = 0.1 mAdc) | V _{CE(sat)} | _ | 0.2 | Vdc |
| Base-Emitter Saturation Voltage (IC = 1.0 mAdc, IB = 0.1 mAdc) | V _{BE(sat)} | - | 0.8 | Vdc |
| Base-Emitter On Voltage (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc) SMALL-SIGNAL CHARACTERISTICS | V _{BE(on)} | _ | 0.8 | Vdc |
| Current-Gain — Bandwidth Product(2) (IC = 10 mAdc, V _{CE} = 10 Vdc, f = 30 MHz) | fΤ | 60 | 300 | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, I _E = 0, f = 140 kHz, emitter guarded) | C _{cb} | _ | 12 | ρF |
| Emitter-Base Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 140 kHz, collector guarded) | C _{eb} | _ | 50 | pF |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

⁽²⁾ fT = |hfe| • ftest.

2N5086 2N5087

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|---------------|
| Collector-Emitter Voltage | VCEO | 50 | Vdc |
| Collector-Base Voltage | VCBO | 50 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | İC | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

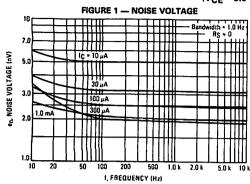
| Characteristic | Symbol | Max | Unit |
|---|----------------------|-----|------|
| Thermal Resistance, Junction to Case | ReJC | 125 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 357 | °C/W |

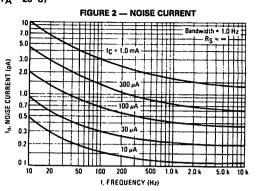
(1) R_{BJA} is measured with the device soldered into a typical printed circuit board.

| Characteristic | | Symbol | Min | Max | Unit |
|---|------------------|---------------------|------------|------------|---------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 1.0 mAdc, Ig = 0) | | V(BR)CEO | 50 | - | - Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | | V(BR)CBO | 50 | _ | Vdc |
| Collector Cutoff Current (VCB = 10 Vdc, I _E = 0) (VCB = 35 Vdc, I _E = 0) | | СВО | _ | 10 50 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | | tEBO | | 50 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 100 μAdc, V _{CE} = 5.0 Vdc) | 2N5086 2N5087 | hFE | 150 250 | 500 800 | _ |
| (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc) | 2N5086 2N5087 | | 150 250 | | |
| (I _C = 10 mAdc, V _{CE} = 5.0 Vdc)(2) | 2N5086 2N5087 | | 150 250 | = | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | | VCE(sat) | | 0.3 | Vdc |
| Base-Emitter On Voltage (IC = 1.0 mAdc, VCE = 5.0 Vdc) | | V _{BE(on)} | | 0.85 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | · · · · · · · |
| Current-Gain — Bandwidth Product (IC = 500 µAdc, VCE = 5.0 Vdc, f = 20 MHz) | | fT | 40 | | MHz |
| Collector-Base Capacitance (VCB = 5.0 Vdc, IE = 0, f = 100 kHz) | | C _{cb} | _ | 4.0 | pF |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | 2N5086 2N5087 | h _{fe} | 150 250 | 600 900 | _ |
| Noise Figure (IC = 20 µAdc, VCE = 5.0 Vdc, Rg = 10 k ohms, f = 10 Hz to 15.7 kHz) | 2N5086 2N5087 | NF | - 1 | 3.0 2.0 | dB |
| (I _C = 100 μ Adc, V _{CE} = 5.0 Vdc, R _S = 3.0 k ahms, f = 1.0 kHz) | 2N5086 2N5087 | | | 3.0 2.0 | |

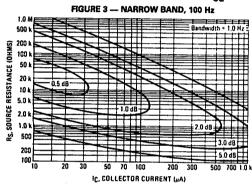
(2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

TYPICAL NOISE CHARACTERISTICS (VCE = 5.0 Vdc, TA = 25°C)





NOISE FIGURE CONTOURS (VCE = 5.0 Vdc, TA = 25°C)



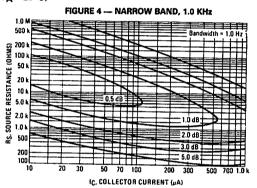


FIGURE 5 - WIDEBAND 10 Hz to 15.7 kH 500 (200 RS. SOURCE RESISTANCE (OHMS) 100 50 I 20 10 (5.0 2.0 1.0 500 5.0 dB-100 70 100 IC. COLLECTOR CURRENT (µA)

Noise Figure is Defined as:

NF =
$$20 \log_{10} \left[\frac{e_n^2 + 4KTR_S + I_n^2R_S^2}{4KTR_S} \right]^{1/2}$$

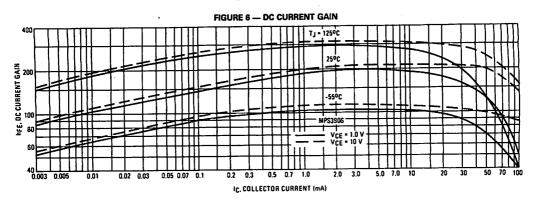
en = Noise Voltage of the Transistor referred to the input. (Figure 3) In = Noise Current of the transistor

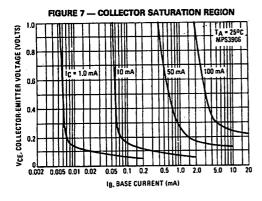
referred to the input (Figure 4)

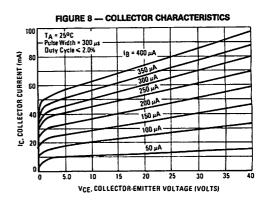
K = Boltzman's Constant (1.38 x 10-23 j/oK)
T = Temperature of the Source Resistance (oK)

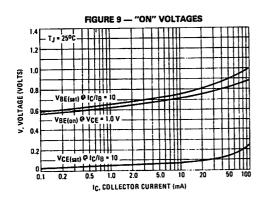
RS = Source Resistance (Ohms)

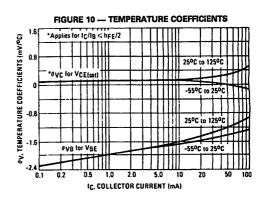
TYPICAL STATIC CHARACTERISTICS



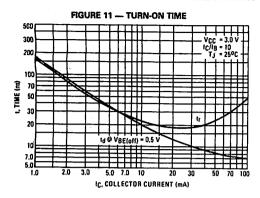


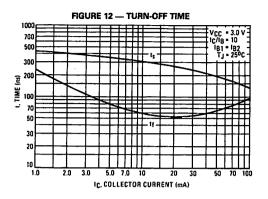


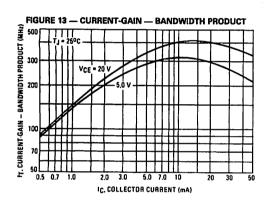


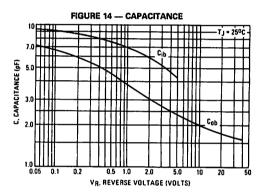


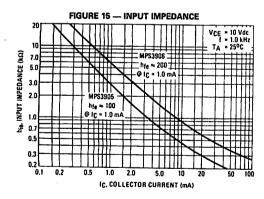
TYPICAL DYNAMIC CHARACTERISTICS











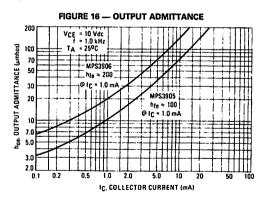


FIGURE 17 - THERMAL RESPONSE

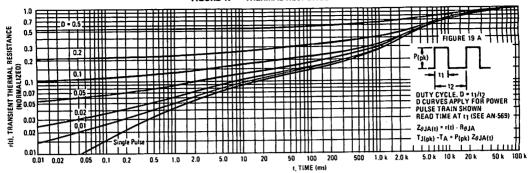
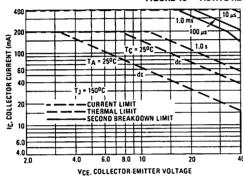


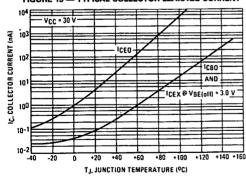
FIGURE 18 - ACTIVE-REGION SAFE OPERATING AREA



The safe operating area curves indicate IC-VCE limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 20 is based upon $T_{J(pk)} = 150^{\circ}C$; T_{C} or T_{A} is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \le 150^{\circ}C$. $T_{J(pk)}$ may be calculated from the data in Figure 19. At high case or ambient temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown. (See AN-415A).

FIGURE 19 — TYPICAL COLLECTOR LEAKAGE CURRENT



DESIGN NOTE: USE OF THERMAL RESPONSE DATA

A train of periodical power pulses can be represented by the model as shown in Figure 19A. Using the model and the device thermal response the normalized effective transient thermal resistance of Figure 19 was calculated for various duty cycles.

To find $Z_{\theta JA(t)}$, multiply the value obtained from Figure 19 by the steady state value $R_{\theta JA}$. Example:

The MPS3905 is dissipating 2.0 watts peak under the following conditions:

t1 = 1.0 ms, t2 = 5.0 ms (D = 0.2)

Using Figure 19 at a pulse width of 1.0 ms and D = 0.2, the reading of r(t) is 0.22.

The peak rise in junction temperature is therefore

 $\triangle T = r(t) \times P(pk) \times R_{\theta}JA = 0.22 \times 2.0 \times 200 = 88^{\circ}C.$ For more information, see AN-569.

MAXIMUM RATINGS

| Rating | Symbol | 2N5088 | 2N5089 | Unit |
|---|-----------------------------------|-------------|--------|---------------|
| Collector-Emitter Voltage | VCEO | 30 | 25 | Vdc |
| Collector-Base Voltage | V _{CBO} | 35 | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 4.5 | | Vdc |
| Collector Current — Continuous | lc | 50 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 2.8 | | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 8.0 | | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|-----|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 125 | °C/W |
| Thermal Resistance, Junction to Ambient | RAJA(1) | 357 | °C/W |

2N5088 2N5089

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MPSA18 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|---|------------------|---------------------|------------|--------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (I _C = 1.0 mAdc, I _B = 0) | 2N5088 2N5089 | V(BR)CEO | 30 25 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | 2N5088 2N5089 | V(BR)CBO | 35 30 | = | Vdc |
| Collector Cutoff Current (V _{CB} = 20 Vdc, I _E = 0) (V _{CB} = 15 Vdc, I _E = 0) | 2N5088 2N5089 | lСВО | _ | 50 50 | nAdc |
| Emitter Cutoff Current $(VEB(off) = 3.0 \text{ Vdc}, I_C = 0)$ $(VEB(off) = 4.5 \text{ Vdc}, I_C = 0)$ | | IEBO | _ | 50 100 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 100 μAdc, V _{CE} = 5.0 Vdc) | 2N5088 2N5089 | hFE | 300 400 | 900 1200 | _ |
| (IC = 1.0 mAdc, VCE = 5.0 Vdc) | 2N5088 2N5089 | | 350 450 | = | |
| (IC = 10 mAdc, V _{CE} = 5.0 Vdc)(2) | 2N5088 2N5089 | | 300 400 | _ | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | | VCE(sat) | _ | 0.5 | Vdc |
| Base-Emitter On Voltage (IC = 10 mAdc, VCE = 5.0 Vdc)(2) | | V _{BE(on)} | | 0.8 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 500 µAdc, VCE = 5.0 Vdc, f = 20 MHz) | | fT | 50 | - | MHz |
| Collector-Base Capacitance (VCB = 5.0 Vdc, I _E = 0, f = 100 kHz) | | C _{cb} | _ | 4.0 | ρF |
| Emitter-Base Capacitance (VBE = 0.5 Vdc, IC = 0, f = 100 kHz) | | C _{eb} | _ | 10 | pF |
| Small-Signal Current Gain (IC = 1.0 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 kHz) | 2N5088 2N5089 | hfe | 350 450 | 1400 1800 | _ |
| Noise Figure (IC = 100 μAdc, V _{CE} = 5.0 Vdc, R _S = 10 kohms, f = 10 Hz to 15.7 kHz) | 2N5088 2N5089 | NF | | 3.0 2.0 | dB |

⁽¹⁾ RgJA is measured with the device soldered into a typical printed circuit board. (2) Pulse Test: Pulse Width < 300 μ s, Duty Cycle < 2.0%.

2N5208

CASE 29-02, STYLE 2 TO-92 (TO-226AA)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|---------------|
| Collector-Emitter Voltage | VCEO | 25 | Vdc |
| Collector-Base Voltage | VCBO | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | lc | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/℃ |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

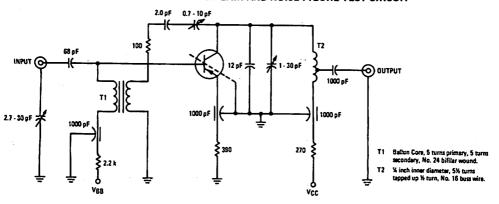
| Characteristic | Symbol | Max | Unit |
|---|---------|-----|------|
| Thermal Resistance, Junction to Case | RAIC | 125 | °C/W |
| Thermal Resistance, Junction to Ambient | Raja(1) | 357 | °C/W |

FI FCTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|-----|------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) | V(BR)CEO | 25 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.1 mAdc, Ig = 0) | V(BR)CBO | 30 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V _{(BR)EBO} | 3.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 10 Vdc, IE = 0) | ІСВО | _ | 10 | nAdc |
| Emitter Cutoff Current (VBE = 2.0 Vdc, IC = 0) | IEBO | _ | 100 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 2.0 mAdc, VCE = 10 Vdc) | pE | 20 | 120 | _ |
| Base-Emitter On Voltage (IC = 2.0 mAdc, VCE = 10 Vdc) | V _{BE(on)} | - | 0.85 | Vđc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product {IC = 2.0 mAdc, VCE = 10 Vdc, f = 100 MHz} | fΤ | 300 | 1200 | MHz |
| Input Capacitance (VgE = 2.0 Vdc, IC = 0, f = 1.0 MHz) | C _{ibo} | - | 4.0 | pF |
| Collector-Base Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | C _{cb} | _ | 1.0 | pF |
| Collector Base Time Constant (IE = 2.0 mAdc, VCB = 10 Vdc, f = 31.8 MHz) | rb′C ^C | _ | 10 | ps |
| Noise Figure (IC = 2.0 mAdc, VCE = 10 Vdc, RS = 75 ohms, f = 100 MHz, BW = 1.0 MHz) | NF | _ | 3.0 | dB |
| FUNCTIONAL TEST | | | | |
| Amplifier Power Gain (IC = 2.0 mAde, VCE = 10 Vdc, f = 100 MHz) | Gpe | 22 | _ | dB |

(1) R_{BJA} is measured with the device soldered into a typical printed circuit board.

FIGURE 1 - 100 MHz POWER GAIN AND NOISE FIGURE TEST CIRCUIT

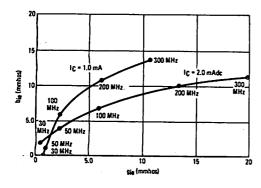


COMMON-EMITTER Y PARAMETERS (Polar Plots)

VCE = 10 Vdc, TA = 25°C

FIGURE 2 - INPUT ADMITTANCE

FIGURE 3 - OUTPUT ADMITTANCE



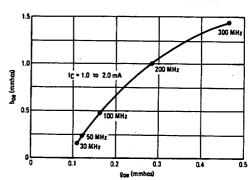


FIGURE 4 - FORWARD TRANSFER ADMITTANCE

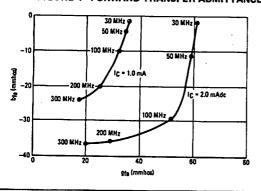
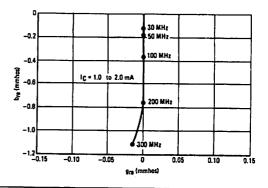
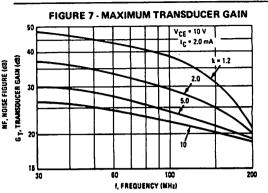


FIGURE 5 - REVERSE TRANSFER ADMITTANCE



STABILITY FACTOR CURVE

FIGURE 6 - POWER GAIN AND NOISE FIGURE 35 f = 100 MHz VCE - 10 V Rs = 75 Ohms 12 30 10 Gpe POWER GAIN (dB) 25 8.0 20 6.0 15 NF 10 5.0 1.0 30 IC. COLLECTOR CURRENT (mAde)



COMMON-EMITTER Y PARAMETERS vs FREQUENCY

VCE = 10 Vdc, TA = 25°C

FIGURE 8 - INPUT ADMITTANCE

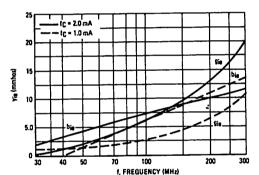


FIGURE 9 - OUTPUT ADMITTANCE

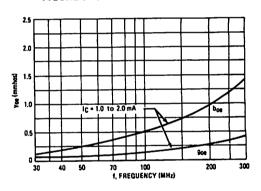


FIGURE 10 - FORWARD TRANSFER ADMITTANCE

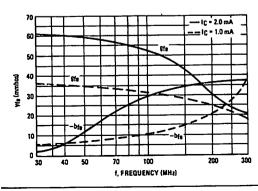
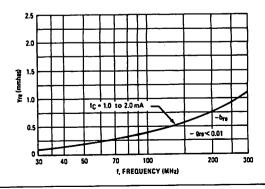


FIGURE 11 - REVERSE TRANSFER ADMITTANCE



STABILITY FACTOR CURVES

FIGURE 12 - OPTIMUM SOURCE ADMITTANCE

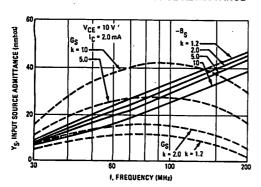
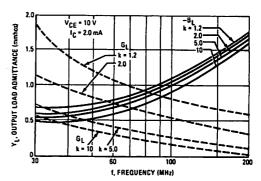


FIGURE 13 - OPTIMUM LOAD ADMITTANCE



When a potentially unstable device is operated without feedback, there is an infinite number of combinations of source and load admittance associated with any given circuit stability factor (k). Equations have been developed for determining the optimum source and load admittance for maximum gain. Figures 7, 12 and 13 provide a solution to the equations for the ZNSZGG.

NOISE FIGURE

FIGURE 14 - FREQUENCY EFFECTS

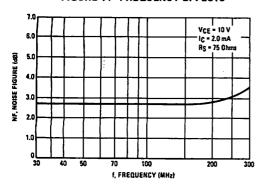


FIGURE 15 - SOURCE RESISTANCE EFFECTS

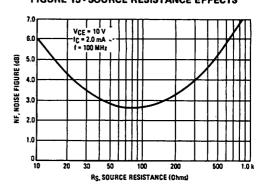


FIGURE 16 - CURRENT-GAIN -- BANDWIDTH PRODUCT

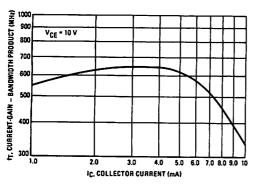
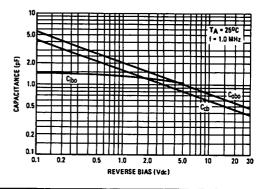
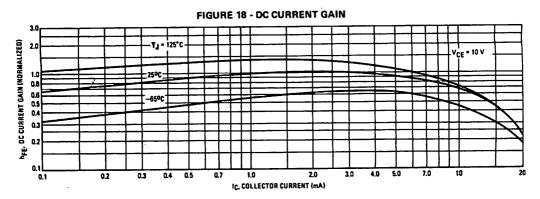


FIGURE 17 - CAPACITANCES





| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|---------------|
| Collector-Emitter Voltage | VCEO | 50 | Vdc |
| Collector-Base Voltage | V _{CBO} | 50 | Vdc |
| Emitter-Base Voltage | VEBO | 4.5 | Vdc |
| Collector Current — Continuous | lc | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|---------|-----|------|
| Thermal Resistance, Junction to Case | RøJC | 125 | °C/W |
| Thermal Resistance, Junction to Ambient | Raja(1) | 357 | °CW |

2N5209 2N5210

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MPSA18 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|---|----------------------|------------|------------|--------------|
| OFF CHARACTERISTICS | | | - | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, Ig = 0) | | V(BR)CEO | 50 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.1 mAdc, IE = 0) | | V(BR)CBO | 50 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 35 Vdc, I _E = 0) | | ICBO | _ | 50 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, I _C = 0) | - · · · · · · · · · · · · · · · · · · · | IEBO | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 100 μAdc, V _{CE} = 5.0 Vdc) | 2N5209 2N5210 | hFE | 100 200 | 300 600 | _ |
| $(I_C = 1.0 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$ | 2N5209 2N5210 | | 150 250 | = | <u> </u> |
| (IC = 10 mAdc, VCE = 5.0 Vdc)(2) | 2N5209 2N5210 | | 150 250 | = | |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | | V _{CE(sat)} | _ | 0.7 | Vdc |
| Base-Emitter On Voltage (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc) | | V _{BE(on)} | | 0.85 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (I _C = 500 μAdc, V _{CE} = 5.0 Vdc, f = 20 MHz) | | ft | 30 | _ | MHz |
| Collector-Base Capacitance {VCB = 5.0 Vdc, IE = 0, f = 100 kHz} | | C _{cb} | _ | 4.0 | pF |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | 2N5209 2N5210 | h _{fe} | 150 250 | 600 900 | _ |
| Noise Figure (I _C = 20 μAdc, V _{CE} = 5.0 Vdc, R _S = 22 k ohms, f = 10 Hz to 15.7 kHz) | 2N5209 2N5210 | NF | = | 3.0 2.0 | dB |
| (I _C = 20 μ Adc, V _{CE} = 5.0 Vdc, R _S = 10 k ohms, f = 1.0 kHz) | 2N5209 2N5210 | | _ | 4.0 3.0 | |

⁽¹⁾ Raja is measured with the device soldered into a typical printed circuit board. (2) Pulse Test: Pulse Width = 300 μ s, Duty Cycle = 2.0%.

2N5222

CASE 29-02, STYLE 2 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|---------------|
| Collector-Emitter Voltage | VCEO | 15 | Vdc |
| Collector-Base Voltage | VCBO | 20 | Vdc |
| Emitter-Base Voltage | VEBO | 2.0 | Vdc |
| Collector Current — Continuous | lc | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| *************************************** | | | |
|---|-------------------|-----|------|
| Characteristic | Symbol | Max | Unit |
| Thermal Resistance, Junction to Case | R _Ø JC | 125 | •c/w |
| Thermal Resistance, Junction to Ambient | Raja(1) | 357 | °C∕W |

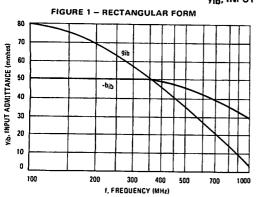
| Characteristic | Symbol | Min | Max | Unit |
|---|----------------------|--------------|-----|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) | V(BR)CEO | 15 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μ Adc, IE = 0) | V(BR)CBO | 20 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 µAdc, I _C = 0) | V(BR)EBO | 2.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 10 Vdc, IE = 0) | ІСВО | - | 100 | nAdc |
| Emitter Cutoff Current (VBE = 2.0 Vdc, IC = 0) | IEBO | _ | 100 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain(2) (I _C = 4.0 mAdc, V _{CE} = 10 Vdc) | hFE | 20 | 150 | - |
| Collector-Emitter Saturation Voltage (I _C = 4.0 mAdc, I _B = 400 µAdc) | V _{CE(sat)} | _ | 1.0 | Vdc |
| Base-Emitter On Voltage (I _C = 4.0 mAdc, I _B = 400 μAdc) | VBE(on) | _ | 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | , |
| Current-Gain — Bendwidth Product (I _C = 4.0 mAdc, V _{CE} = 10 Vdc, f = 20 MHz) | fτ | 450 | _ | MHz |
| Collector-Base Capacitance {VCB = 10 Vdc, IE = 0, f = 1.0 MHz} | C _{cb} | _ | 1.3 | pF |
| Small-Signal Current Gain (I _C = 4.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{fe} | 20 | 300 | |

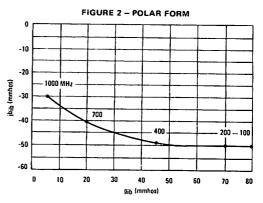
⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board. (2) Pulse Test: Pulse Width ~ 300 µs, Duty Cycle ~ 2.0%.

COMMON-BASE y PARAMETERS versus FREQUENCY

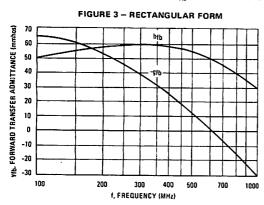
 $(V_{CB} = 10 \text{ Vdc, } I_{C} = 4.0 \text{ mAdc, } T_{A} = 25^{\circ}C)$

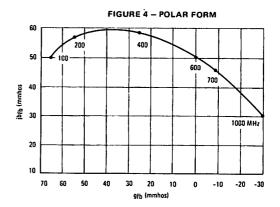
yib, INPUT ADMITTANCE





Yfb. FORWARD TRANSFER ADMITTANCE

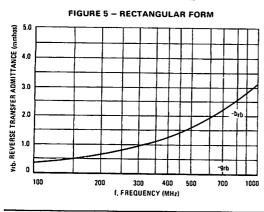


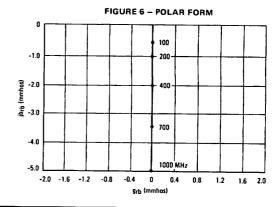


COMMON-BASE y PARAMETERS versus FREQUENCY

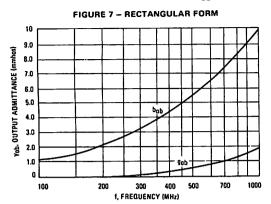
(VCB = 10 Vdc, IC = 4.0 mAdc, TA = 25°C)

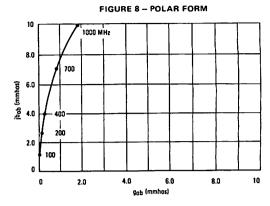
yrb, REVERSE TRANSFER ADMITTANCE





Yob, OUTPUT ADMITTANCE





| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|---------------|
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Base Voltage | V _{CBO} | 25 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | Ic | 100 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12.0 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | . ℃ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|---------|-----|------|
| Thermal Resistance, Junction to Case | Rejc | 125 | °C/W |
| Thermal Resistance, Junction to Ambient | ReJA(1) | 357 | °C/W |

⁽¹⁾ Reja is measured with the device soldered into a typical printed circuit board.

2N5223

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N3903 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|------------------|-----|----------|---------|
| OFF CHARACTERISTICS | | | 1 11111 | 1 One |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 20 | — | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 25 | - | Vdc |
| (IE = 100 µAdc, IC = 0) | V(BR)EBO | 3.0 | | Vdc |
| Collector Cutoff Current (VCB = 10 Vdc, IE = 0) | ICBO | _ | 100 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | ^I EBO | | 500 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 2.0 mAdc, VCE = 10 Vdc) | pŁE | 50 | 800 | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | VCE(sat) | | 0.7 | Vdc |
| Bese-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | VBE(sat) | _ | 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | <u> </u> | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, V _{CE} = 10 Vdc, f = 20 MHz) | fT | 150 | _ | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, Ig = 0, f = 1.0 MHz) | C _{cb} | _ | 4.0 | ρF |
| Small-Signal Current Gain (IC = 2.0 mAde, VCE = 10 Vdc, f = 1.0 kHz) | hfe | 50 | 1600 | _ |

2N5224

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| IAIWVIIAIGIAI UWI IIAGG | | | |
|--|----------------------|-------------|---------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 12 | Vdc |
| Collector-Base Voltage | VCBO | 25 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 200 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

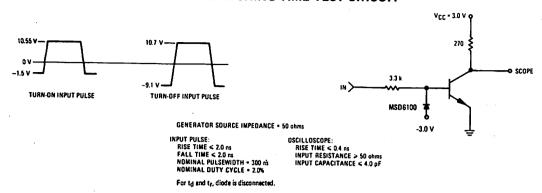
| ILIEUME GIRAROLEIROLIGO | | | , |
|---|---------|-----|------|
| Characteristic | Symbol | Max | Unit |
| Thermal Resistance, Junction to Case | RøJC | 125 | °C/W |
| Thermal Resistance, Junction to Ambient | Raja(1) | 357 | °CW |

⁽¹⁾ Raja is measured with the device soldered into a typical printed circuit board.

| | ACTERISTICS (T _A = 25°C unless otherwise noted.) Characteristic | Symbol | Min | Max | Unit |
|---|---|-----------------|-------------|--|------|
| OFF CHARACTERISTI | cs | | | <u>. </u> | |
| Collector-Emitter Brea | | V(BR)CEO | 12 | | Vdc |
| Collector-Base Breakd | lown Voltage | V(BR)CBO | 25 | | Vdc |
| Emitter-Base Breakdo | wn Voltage | V(BR)EBO | 5.0 | | Vdc |
| Collector Cutoff Curre (VCB = 15 Vdc, IE | ent | ІСВО | | 500 | nAdc |
| Emitter Cutoff Curren (VRF = 4.0 Vdc, IC | t | IEBO | _ | 100 | μAdc |
| ON CHARACTERISTI | | | | | |
| DC Current Gain (IC = 10 mAdc, VC (IC = 100 mAdc, V | | PEE | 40 15 | 400 — | _ |
| Collector-Emitter Sat | uration Voltage | VCE(sat) | - | 0.35 | Vdc |
| Base-Emitter Saturati | ion Voltage | VBE(sat) | - | 0.9 | Vdc |
| SMALL-SIGNAL CHA | | | | | |
| Current-Gain — Band | dwidth Product E = 10 Vdc, f = 100 MHz) | fτ | 250 | | MHz |
| Collector-Base Capac | | C _{cb} | | 4.0 | pF |
| SWITCHING CHARA | | | | | |
| Delay Time | (VCC = 3.0 Vdc, VBE(off) = 1.5 Vdc | td | | 25 | ns |
| Rise Time | IC = 10 mAdc, IB1 = 3.0 mAdc) | t _F | | 20 | ns |
| Storage Time | (Vcc = 3.0 Vdc, | tg | <u> </u> | 35 | ns |
| Fall Time | IC = 10 mA, IB1 = IB2 = 3.0 mAdc) | tf | I - | 25 | ns |

(2) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

FIGURE 1 - SWITCHING TIME TEST CIRCUIT



2N5225

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|-----------------------------------|-------------|---------------|
| Collector-Emitter Voltage | VCEO | 25 | Vdc |
| Collector-Base Voltage | V _{CBO} | 25 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | l _C | 200 | mAdc |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12.0 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| I | Characteristic | Symbol | Max | Unit |
|---|---|----------------------|-----|------|
| | Thermal Resistance, Junction to Case | RAJC | 125 | °C/W |
| | Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 357 | °C/W |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

hfe

| Characteristic | Symbol | Min | Max | Unit |
|--|-----------------|----------|-----|------|
| OFF CHARACTERISTICS | - | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, Ig = 0) | V(BR)CEO | 25 | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 25 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 µAdc, IC = 0) | V(BR)EBO | 4.0 | - | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) | ІСВО | | 300 | nAdc |
| Emitter Cutoff Current (VBE = 4.0 Vdc, IC = 0) | lEBO | | 500 | nAdc |
| ON CHARACTERISTICS(2) | | | | |
| DC Current Gain (IC = 10 mAdc, VCE = 10 Vdc) (IC = 50 mAdc, VCE = 10 Vdc) | hFE | 25 30 | 600 | - |
| Collector-Emitter Saturation Voltage (IC = 100 mAdc, Ig = 10 mAdc) | VCE(sat) | _ | 0.8 | Vdc |
| Base-Emitter Saturation Voltage (IC = 100 mAdc, IB = 10 mAdc) | VBE(sat) | | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (I _C = 20 mAdc, V _{CE} = 10 Vdc, f = 20 MHz) | fτ | 50 | | MHz |
| Collector-Base Capacitance (VCB = 5.0 Vdc, IE = 0, f = 1.0 MHz) | C _{cb} | _ | 20 | pF |
| | | | 1 | 1 |

(2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

Small-Signal Current Gain (IC = 50 mAdc, VCE = 10 Vdc, f = 1.0 kHz)

1800

| Rating | Symbol | Value | Unit |
|---|----------------------|-------------|---------------|
| Collector-Emitter Voltage | VCEO | 25 | Vdc |
| Collector-Base Voltage | VCBO | 25 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | lc | 500 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12.0 | Watt mW/°C |
| Operating and Storage Junction | TJ, T _{stg} | -55 to +150 | ္ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|----------------------|-----|------|
| Thermal Resistance, Junction to Case | Resc | 125 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 357 | °C/W |

⁽¹⁾ Reja is measured with the device soldered into a typical printed circuit board.

2N5226

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

PNP SILICON

| Symbol | Min | Max | Unit |
|------------------|--|---|---|
| | | | |
| V(BR)CEO | 25 | _ | Vdc |
| V(BR)CBO | 25 | _ | Vdc |
| V(BR)EBO | 4.0 | _ | Vdc |
| ІСВО | | 300 | nAdc |
| I _{EBO} | _ | 500 | nAdc |
| | | -1 | |
| phE | 25 30 | 600 | - |
| VCE(sat) | | 0.8 | Vdc |
| VBE(sat) | _ | 1.0 | Vdc |
| | | · | |
| fr | 50 | _ | MHz |
| C _{cb} | _ | 20 | pF |
| hfe | 30 | 1800 | _ |
| | V(BR)CEO V(BR)CBO V(BR)EBO ICBO IEBO VCE(sat) VBE(sat) ft Ccb | V(BR)CEO 25 V(BR)CBO 25 V(BR)EBO 4.0 ICBO — IEBO — NFE 25 30 VCE(sat) — VBE(sat) — fT 50 Ccb — | V(BR)CEO 25 — V(BR)CBO 25 — V(BR)EBO 4.0 — ICBO — 300 IEBO — 500 hfE 25 — 600 VCE(sat) — 0.8 VBE(sat) — 1.0 fT 50 — Ccb — 20 |

⁽²⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

2N5227

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| MANUAL INCIDIO | | | |
|--|----------------------|-------------|---------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 30 | Vdc |
| Collector-Base Voltage | VCBO | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | lc | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12.0 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|----------------------|------|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 200 | °C/W |

(1) R_{BJA} is measured with the device soldered into a typical printed circuit board.

Refer to 2N3905 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|----------------------|----------|------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 30 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 30 | _ | Vđc |
| Emitter-Base Breakdown Voltage (IE = 100 µAdc, IC = 0) | V(BR)EBO | 3.0 | | Vdc |
| Collector Cutoff Current (VCB = 10 Vdc, IE = 0) | ICBO | _ | 100 | nAdc |
| Emitter Cutoff Current (VBE = 2.0 Vdc, IC = 0) | ^I EBO | _ | 500 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 100 µAdc, V _{CE} = 10 Vdc) (I _C = 2.0 mAdc, V _{CE} = 10 Vdc) | hFE | 30 50 | | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | VCE(sat) | | 0.4 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | V _{BE(sat)} | | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 10 Vdc, f = 20 MHz) | fT | 100 | - | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | C _{cb} | _ | 5.0 | pF |
| Small-Signal Current Gain (I _C = 2.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{fe} | 50 | 1500 | _ |

| Rating | Symbol | Value | Unit |
|---|----------------------|-------------|---------------|
| Collector-Emitter Voltage | VCEO | 5.0 | Vdc |
| Collector-Emitter Voltage | VCES | 6.0 | Vdc |
| Collector-Base Voltage | VCBO | 5.0 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | lC . | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|----------------------|-----|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 125 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 357 | °C/W |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

2N5228

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

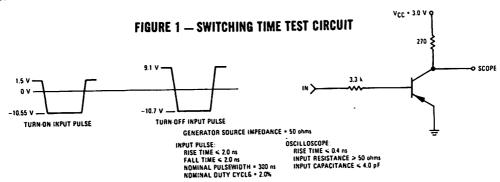
SWITCHING TRANSISTOR

PNP SILICON

Refer to MPS3640 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|----------|----------------|---------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, IB = 0) | V(BR)CEO | 5.0 | | Vdc |
| Collector-Emitter Breakdown Voltage (I _C = 100 µAdc, V _{BE} = 0) | V(BR)CES | 6.0 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μ Adc, IE = 0) | V(BR)CBO | 5.0 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | V _{(BR)EBO} | 3.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 4.0 Vdc, VBE = 0) | CES | | 100 | nAdc |
| Emitter Cutoff Current (VBE = 2.5 Vdc, IC = 0) | IEBO | _ | 100 | μAdc |
| ON CHARACTERISTICS | | | | , m-100 |
| DC Current Gain (I _C = 10 mAdc, V_{CE} = 0.3 Vdc) (I _C = 50 mAdc, V_{CE} = 1.0 Vdc)(2) | hFE | 30 15 | _ | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 3.0 mAdc) | V _{CE(sat)} | _ | 0.4 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 3.0 mAdc) | V _{BE(sat)} | 0.65 | 1.25 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 5.0 Vdc, f = 100 MHz) | fτ | 300 | _ | MHz |
| Collector-Base Capacitance (VCB = 5.0 Vdc, IE = 0, f = 1.0 MHz) | C _{cb} | | 5.0 | pF |
| SWITCHING CHARACTERISTICS | | | | |
| Delay Time (V _{CC} = 3.0 Vdc, V _{BE(off)} = 1.5 Vdc | td | _ | 25 | ns |
| Rise Time I _C = 10 mAdc, I _{B1} = 3.0 mAdc) | tr | | 50 | ns |
| Storage Time (V _{CC} = 3.0 Vdc, I _C = 10 mA, | tg | | 90 | ns |
| Fall Time IB1 = IB2 = 3.0 mAdc) | tf | | 50 | ns |

⁽²⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.



| Rating | Symbol | 2N5400 | 2N5401 | Unit |
|---|-----------------------------------|-------------|--------|---------------|
| Collector-Emitter Voltage | VCEO | 120 | 150 | Vdc |
| Collector-Base Voltage | VCBO | 130 | 160 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc |
| Collector Current — Continuous | lc | 600 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12.0 | | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------|------|
| Thermal Resistance, Junction to Case | RAJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | RAJA | 200 | *C/W |

2N5400 2N5401

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

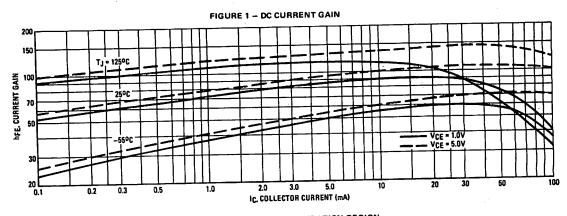
PNP SILICON

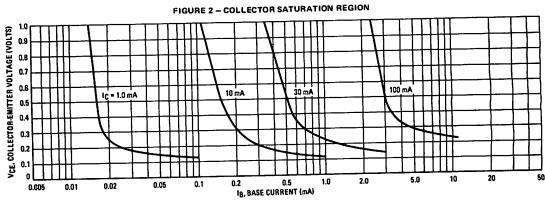
| ELECTRICAL | CHARACTERISTICS /T. | = 25°C upless athornies ==tod \ |
|------------|---------------------|---------------------------------|
| | | |

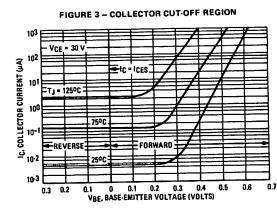
| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------------------------|------------------|------------|------------------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (I _C = 1.0 mAdc, I _B = 0) | 2N5400 2N5401 | V(BR)CEO | 120 150 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μAdc, IE = 0) | 2N5400 2N5401 | V(BR)CBO | 130 160 | = | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | - | Vdc |
| Collector Cutoff Current (VCB = 100 Vdc, IE = 0) (VCB = 120 Vdc, IE = 0) (VCB = 120 Vdc, IE = 0, TA = 100°C) (VCB = 120 Vdc, IE = 0, TA = 100°C) | 2N5400 2N5401 2N5400 2N5401 | СВО | = | 100 50 100 50 | nAdc µAdc |
| Emitter Cutoff Current (VEB = 3.0 Vdc, I _C = 0) | | ¹ EBO | - | 50 | nAdc |
| ON CHARACTERISTICS(1) | | | | L | L |
| DC Current Gain (IC = 1.0 mAdc, VCE = 5.0 Vdc) | 2N5400 2N5401 | ptE | 30 50 | | _ |
| (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) | 2N5400 2N5401 | | 40 60 | 180 240 | |
| (IC = 50 mAdc, VCE = 5.0 Vdc) | 2N5400 2N5401 | | 40 50 | _ | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc) | , | VCE(sat) | _ | 0.20 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc) | | VBE(sat) | | 1.0 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, V _{CE} = 10 Vdc, f = 100 Mhz) | 2N5400 2N5401 | fT | 100 100 | 400 300 | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | | Cobo | _ | 6.0 | pF |

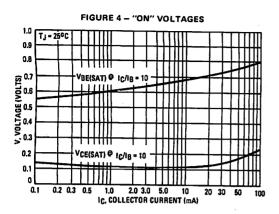
| Characteristic | | Symbol | Min | Max | Unit |
|---|------------------|-----------------|----------|------------|------|
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | 2N5400 2N5401 | h _{fe} | 30 40 | 200 200 | _ |
| Noise Figure (I _C = 250 µAdc, V _{CE} = 5.0 Vdc, R _S = 1.0 kohm, f = 10 Hz to 15.7 kHz) | | NF | _ | 8.0 | dB |

⁽¹⁾ Pulse Test: Pulse Width = 300 μ s, Duty Cycle = 2.0%.









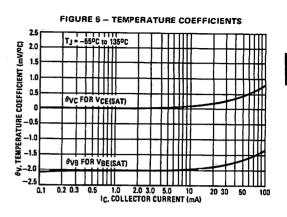
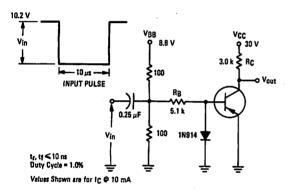


FIGURE 6 - SWITCHING TIME TEST CIRCUIT



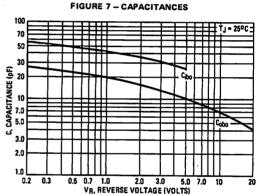
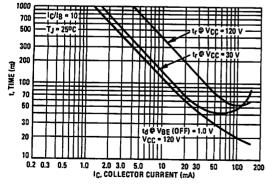
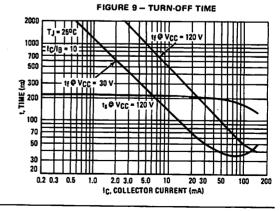


FIGURE 8 - TURN-ON TIME





2N5550 2N5551

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MAXIMUM HATINGS | | | | |
|---|-----------------------------------|------------|-----------|--------------|
| Rating | Symbol | 2N5550 | 2N5551 | Unit |
| Collector-Emitter Voltage | VCEO | 140 | 160 | Vdc |
| Collector-Base Voltage | VCBO | 160 | 180 | Vdc |
| Emitter-Base Voltage | VEBO | 6 | .0 | Vdc |
| Collector Current — Continuous | lc | 600 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 2.8 | | mW/℃ |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | | .0 3.0 | Watt mW/℃ |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 t | o + 150 | ℃ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|----------------------|-----|------|
| Thermal Resistance, Junction to Case | R _Ø JC | 125 | °CW |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 357 | °C/W |

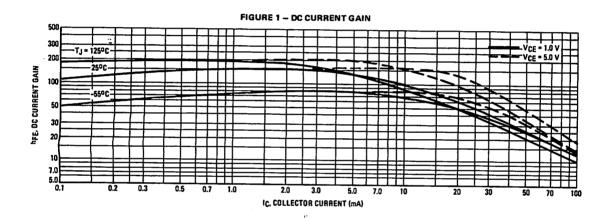
⁽¹⁾ Raja is measured with the device soldered into a typical printed circuit board.

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------------------------|------------------|---|------------------------|--------------|
| OFF CHARACTERISTICS | | | | | _ |
| Collector-Emitter Breakdown Voltage(2) (IC = 1.0 mAdc, Ig = 0) | 2N5550 2N5551 | V(BR)CEO | 140 160 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μAdc, I _E = 0) | 2N5550 2N5551 | V(BR)CBO | 160 180 | = | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | | V(BR)EBO | 6.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 100 Vdc, IE = 0) (VCB = 120 Vdc, IE = 0) (VCB = 100 Vdc, IE = 0, TA = 100°C) (VCB = 120 Vdc, IE = 0, TA = 100°C) | 2N5550 2N5551 2N5550 2N5551 | ICBO | ======================================= | 100 50 100 50 | nAdc µAdc |
| Emitter Cutoff Current (V _{EB} = 4.0 Vdc, I _C = 0) | | ¹ EBO | | 50 | nAdc |
| ON CHARACTERISTICS(2) | | | - | T | |
| DC Current Gain (IC = 1.0 mAdc, VCE = 5.0 Vdc) | 2N5550 2N5551 | hFE | 60 80 | = | |
| (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) | 2N5550 2N5551 | | 60 80 | 250 250 | |
| (I _C = 50 mAdc, V _{CE} = 5.0 Vdc) | 2N5550 2N5551 | | 20 30 | = | ļ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | Both Types | VCE(sat) | _ | 0.15 | Vdc |
| (IC = 50 mAdc, IB = 5.0 mAdc) | 2N5550 2N5551 | | | 0.25 0.20 | ļ |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | Both Types | VBE(sat) | - | 1.0 | Vdc |
| (IC = 50 mAdc, IB = 5.0 mAdc) | 2N5550 2N5551 | | = | 1.2 1.0 | |

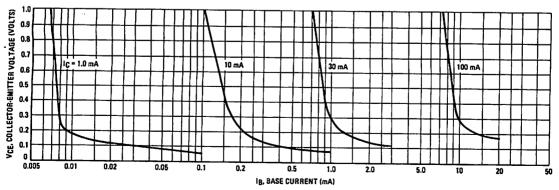
2N5550, 2N5551

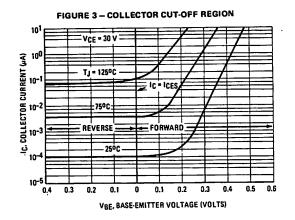
| Characteristic | | Symbol | Min | Max | Unit |
|---|------------------|------------------|-----|-----------|------|
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 10 Vdc, f = 100 MHz) | | fT | 100 | 300 | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | | Cobo | _ | 6.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | 2N5550 2N5551 | C _{ibo} | _ | 30 20 | pF |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | | h _{fe} | 50 | 200 | _ |
| Noise Figure (I _C = 250 µAdc, V _{CE} = 5.0 Vdc, R _S = 1.0 kohm, f = 10 Hz to 15.7 kHz) | 2N5550 2N5551 | NF | _ | 10 8.0 | dВ |

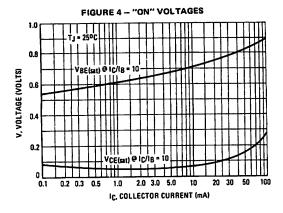
⁽²⁾ Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.











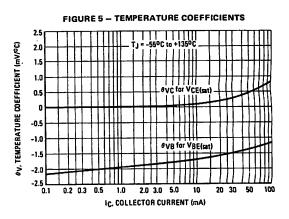
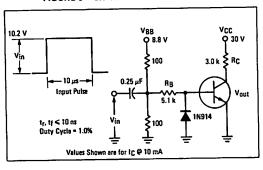
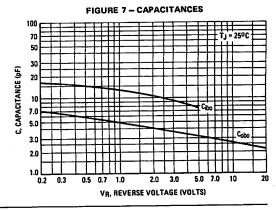
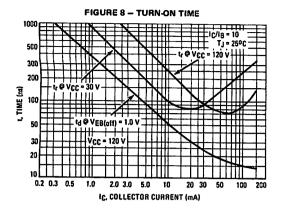


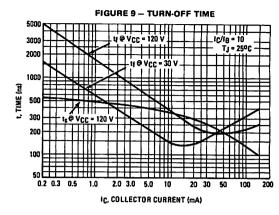
FIGURE 6 - SWITCHING TIME TEST CIRCUIT





2N5550, 2N5551





2N5771

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

SWITCHING TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| MINAVIIAI OIAI IIA IIIA OO | | | |
|---|-----------------------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 15 | Vdc |
| Collector-Base Voltage | VCBO | 15 | Vdc |
| Emitter-Base Voltage | VEBO | 4.5 | Vdc |
| Collector Current — Continuous | lc | 50 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.625 | Watts mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |
| Lead Temperature | ΤL | 260 | °C |

| ELECTRICAL | CHARACTERISTICS IT | 25°C unless otherwise noted) |
|------------|--------------------|-------------------------------|

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|----------------------|---------------------|----------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 3.0 mA)(1) | V(BR)CEO | 15 | | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 100 μA) | V(BR)CES | 15 | | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μA) | V(BR)CBO | 15 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μA) | V(BR)EBO | 4.5 | | Vdc |
| Collector Cutoff Current (VCB = 8.0 Vdc) | ICBO | | 10 | nA |
| Collector Cutoff Current (VCE = 8.0 Vdc) (VCE = 8.0 Vdc, TA = 125°C) | ICES | | 10 5.0 | nA μA |
| Emitter Cutoff Current (VBE = 4.5 Vdc) | IEBO | | 1.0 | μА |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 1.0 mA, V _{CE} = 0.5 Vdc)(1) (I _C = 10 mA, V _{CE} = 0.3 Vdc)(1) (I _C = 50 mA, V _{CE} = 1.0 Vdc)(1) (I _C = 10 mA, V _{CE} = 0.3 Vdc, T _A = -55°C) | hFE | 35 50 40 20 | 120 — — | _ |
| Collector-Emitter Saturation Voltage(1) (IC = 1.0 mA, IB = 0.1 mA) (IC = 10 mA, IB = 1.0 mA) (IC = 50 mA, IB = 5.0 mA) | VCE(sat) | 1 1 1 | 0.15 0.18 0.6 | Vdc |
| Base-Emitter Saturation Voltage(1) ($I_C=1.0$ mA, $I_B=0.1$ mA) ($I_C=10$ mA, $I_B=1.0$ mA) ($I_C=50$ mA, $I_B=5.0$ mA) | V _{BE(sat)} | 0.75 — | 0.8 0.95 1.5 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Collector-Base Capacitance (V _{CB} = 5.0 Vdc, f = 140 kHz) | C _{cb} | - | 3.0 | pF |
| Emitter-Base Capacitance (V _{BE} = 0.5 Vdc, f = 140 kHz) | Ceb | | 3.5 | pF |
| Small-Signal Current Gain (IC = 10 mA, VCE = 10 Vdc, f = 100 MHz) | h _{fe} | 8.5 | _ | |
| SWITCHING CHARACTERISTICS | | | <u> </u> | , |
| Storage Time (I _C = 10 mA, I _{B1} ~ I _{B2} ~ 10 mA) | t _s | _ | 20 | ns |
| Turn-On Time ($I_C = 10 \text{ mA}$, $I_B = 1.0 \text{ mA}$) | ton | _ | 15 | ns |
| Turn-Off Time (I _C = 10 mA, I _{B1} = I _{B2} = 1.0 mA) | toff | | 20 | ns |

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | VCBO | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 12 | Vdc |
| Collector Current — Continuous | Ic | 500 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | င့ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|----------------------|------|------|
| Thermal Resistance, Junction to Case | ReJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 200 | °C/W |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

2N6426 2N6427

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

DARLINGTON TRANSISTOR

NPN SILICON

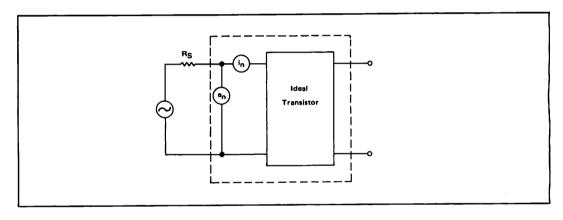
| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|------------------|----------------------|------------------|-------------|--------------------|------|
| OFF CHARACTERISTICS | | | | -7- | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, IB = 0) | | V(BR)CEO | 40 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μAdc, IE = 0) | | V(BR)CBO | 40 | | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | | V(BR)EBO | 12 | _ | - | Vdc |
| Collector Cutoff Current (VCE = 25 Vdc, IB = 0) | | ICEO | _ | | 1.0 | μAdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0) | | СВО | _ | _ | 50 | nAdc |
| Emitter Cutoff Current (VBE = 10 Vdc, IC = 0) | | IEBO | _ | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain(2) (IC = 10 mAdc, VCE = 5.0 Vdc) | 2N6426 2N6427 | hFE | 20,000 10,000 | Ξ | 200,000 100,000 | = |
| (IC = 100 mAdc, VCE = 5.0 Vdc) | 2N6426 2N6427 | | 30,000 20,000 | _ | 300,000 200,000 | |
| (IC = 500 mAdc, VCE = 5.0 Vdc) | 2N6426 2N6427 | | 20,000 14,000 | _ | 200,000 | |
| Collector-Emitter Saturation Voltage (I _C = 50 mAdc, I _B = 0.5 mAdc) (I _C = 500 mAdc, I _B = 0.5 mAdc) | | VCE(sat) | 1 1 | 0.71 0.9 | 1.2 1.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 500 mAdc, IB = 0.5 mAdc) | | V _{BE(sat)} | - | 1.52 | 2.0 | Vdc |
| Base-Emitter On Voltage (IC = 50 mAdc, VCE = 5.0 Vdc) | | V _{BE(on)} | _ | 1.24 | 1.75 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | <u> </u> | |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | | C _{obo} | _ | 5.4 | 7.0 | pF |
| Input Capacitance (VBE = 1.0 Vdc, I _C = 0, f = 1.0 MHz) | | Cibo | _ | 10 | 15 | pF |

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|------------------|-----------------|------------------|------------|--------------|-------|
| Input Impedance (IC = 10 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | 2N6426 2N6427 | hie | 100 50 | | 2000 1000 | kΩ |
| Small-Signal Current Gain (IC = 10 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | 2N6426 2N6427 | h _{fe} | 20,000 10,000 | - | = | _ |
| Current Gain — High Frequency (IC = 10 mAdc, VCE = 5.0 Vdc, f = 100 MHz) | 2N6426 2N6427 | h _{fe} | 1.5 1.3 | 2.4 2.4 | _ | _ |
| Output Admittance (IC = 10 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | | h _{Oe} | _ | _ | 1000 | μmhos |
| Noise Figure (IC = 1.0 mAdc, VCE = 5.0 Vdc, RS = 100 k Ω , f = 10 kHz to 15.7 kHz) | | NF | _ | 3.0 | 10 | dB |

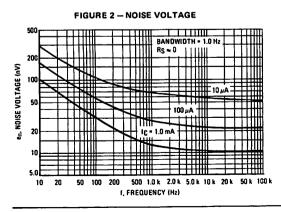
⁽²⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

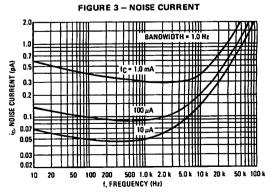
FIGURE 1 - TRANSISTOR NOISE MODEL



NOISE CHARACTERISTICS

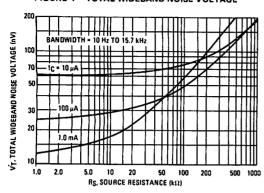
(VCE = 5.0 Vdc, TA = 25°C)

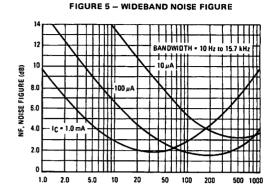




SMALL-SIGNAL DEVICES

FIGURE 4 - TOTAL WIDEBAND NOISE VOLTAGE





RS, SOURCE RESISTANCE (ks)

SMALL-SIGNAL CHARACTERISTICS

FIGURE 6 - CAPACITANCE 20 Tj = 25°C 10 C, CAPACITANCE (DF) 7.0 5.0 3.0 2.0 0.04 0.1 0.2 0.4 10 2.0 4.0 10 20 40 VR. REVERSE VOLTAGE (VOLTS)

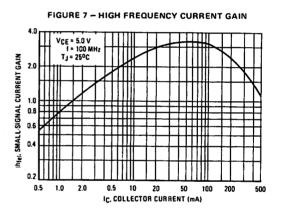


FIGURE 8 - DC CURRENT GAIN 200 k 100 70 s ⊏ 25°C 50 I OC CURRENT GAIN 30 20 10 7.0 k VCE = 5.0 V 5.0 7.0 10 30 50 70 100 200 300 500 IC. COLLECTOR CURRENT (mA)

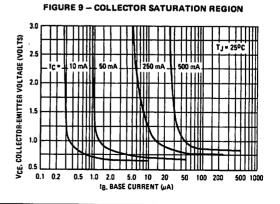


FIGURE 10 - "ON" VOLTAGES

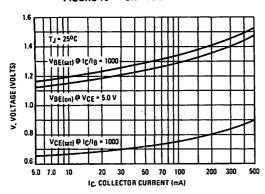


FIGURE 11 - TEMPERATURE COEFFICIENTS

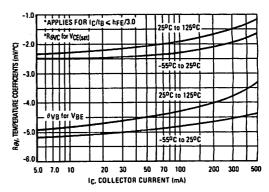


FIGURE 12 - THERMAL RESPONSE

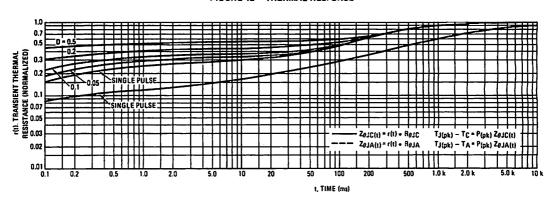
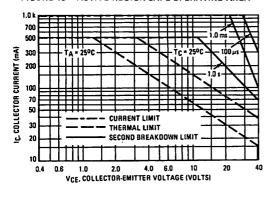
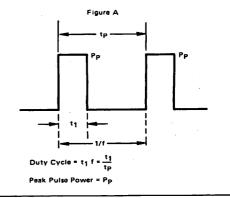


FIGURE 13 - ACTIVE REGION SAFE OPERATING AREA



DESIGN NOTE: USE OF TRANSIENT THERMAL RESISTANCE DATA



| Rating | Symbol | Value | Unit |
|---|----------------------|-------------|----------------|
| Collector-Emitter Voltage 2N6428,A 2N6429,A | VCEO | 50 45 | Vdc |
| Collector-Base Voltage 2N6428,A 2N6429,A | VCBO | 60 55 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | Vdc |
| Collector Current — Continuous | lc | 200 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | RøJA | 200 | °C/W |

2N6428,A 2N6429,A

CASE 29-02, STYLE 1 TO-92 (TO-226AA) AMPLIFIER TRANSISTOR

Refer to MPSA18 for graphs.

| ELECTRICAL | CHARACTERISTICS /T | 25°C unless otherwise noted) |
|------------|--------------------|-------------------------------|
| | | |

| Characteristic | | Symbol | Min | Max | Unit |
|---|----------------------|------------------|------------|-------------|----------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) | 2N6428,A 2N6429,A | V(BR)CEO | 50 45 | = | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.1 mAdc, IE = 0) | 2N6428,A 2N6429,A | V(BR)CBO | 60 55 | = | Vdc |
| Collector Cutoff Current (VCE = 30 Vdc) | | ICEO | _ | 0.025 | μА |
| Collector Cutoff Current (VCB = 30 Vdc, I _E = 0) | | ІСВО | _ | 0.01 | μΑ |
| Emitter Cutoff Current (VEB = 5.0 Vdc, IC = 0) | | [[] EBO | _ | 0.01 | μΑ |
| ON CHARACTERISTICS | | | | | . |
| DC Current Gain (V _{CE} = 5.0 Vdc, I _C = 0.01 mAdc) | 2N6428,A 2N8429,A | pŁE | 250 500 | _ | _ |
| $(V_{CE} = 5.0 \text{ Vdc}, I_{C} = 0.1 \text{ mAdc})$ | 2N6428,A 2N6429,A | | 250 500 | 650 1250 | |
| $(V_{CE} = 5.0 \text{ Vdc}, I_{C} = 1.0 \text{ mAdc})$ | 2N6428,A 2N6429,A | | 250 500 | = | |
| (V _{CE} = 5.0 Vdc, I _C = 10 mAdc) | 2N6428,A 2N6429,A | | 250 500 | _ = | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 0.5 mAdc) (IC = 100 mAdc, Ig = 5.0 mAdc) | | VCE(sat) | _ | 0.2 0.6 | Vdc |
| Base-Emitter On Voltage (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc) | | VBE(on) | 0.56 | 0.66 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 1.0 mAdc, V _{CE} = 5.0 V, f = 100 MHz) | | fΤ | 100 | 700 | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | | C _{obo} | _ | 3.0 | ρF |
| Input Capacitance (VEB = 0.5 Vdc, IC = 0, f = 1.0 MHz) | | C _{ibo} | _ | 8.0 | pF |

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|---|----------------------|-----------------|------------|-------------|--------|
| Input Impedance (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | 2N6428,A 2N6429,A | h _{ie} | 3.0 6.0 | 30 60 | kΩ |
| Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 kHz) | 2N6428,A 2N6429,A | h _{re} | 2.0 5.0 | 20 50 | X 10-4 |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | 2N6428,A 2N6429,A | h _{fe} | 200 400 | 800 1600 | _ |
| Output Admittance (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | 2N6428,A 2N6429,A | h _{oe} | 5.0 10 | 50 100 | μmhos |

NOISE EIGURETOTAL NOISE VOLTAGE CHARACTERISTICS (Vcs = 5.0 V. Ic = 0.1 mA. TA = 25°C).

| MOISE FIGURE TO THE MOISE VOLTAGE CHARACTERISTICS (VCE = 3.5 V. C = 3.7 MAL AZ = 25 SK | | | | | | | | |
|--|-----------|-------------------------|-----------|-------------------------|-----------|----------------|------|-----|
| | NF Ma: | V _T x (1) | NF Ma: | V _T × (2) | NF Max | V _T | U | alt |
| 2N6428 | 3.0 | 18.1 | 6.0 | 5700 | 3.5 | 4.3 | dB | nV |
| 2N6428A | 2.0 | 16.2 | 4.0 | 4600 | 3.0 | 4.1 | ₫₿ | n۷ |
| 2N6429 | 3.0 | 18.1 | 5.0 | 5100 | 4.0 | 4.6 | dB i | n۷ |
| 2N6429A | 2.0 | 16.2 | 3.5 | 4300 | 3.5 | 4.3 | dB | ۱n۷ |

⁽¹⁾ $R_S = 10 \text{ k}\Omega$, BW = 1.0 Hz, f = 100 Hz(2) $R_S = 50 \text{ k}\Omega$, BW = 15.7 kHz, f = 10 Hz–10 kHz(3) $R_S = 500 \Omega$, BW = 1.0 Hz, f = 10 Hz

| D-41. | | 2N6515 | 2N6516 | 2N6517 | |
|--|----------------------|--------------|--------|--------|---------------|
| Rating | Symbol | 2N6518 | 2N6519 | 2N5520 | Unit |
| Collector-Emitter Voltage | VCEO | 250 | 300 | 350 | Vdc |
| Collector-Base Voltage | VCBO | 250 | 300 | 350 | Vdc |
| Emitter-Base Voltage 2N6515, 2N6516, 2N6517 2N6518, 2N6519, 2N6520 | VEBO | 6.0 5.0 | | | Vdc |
| Base Current | I _B | | mAdc | | |
| Collector Current — Continuous | lc | 500 | | | mAdc |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 0.625 5.0 | | | Watt mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | | | ပ္ |
| Lead Temperature ≥ 1/16" from case for 10 seconds | ΤL | 260 | | | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------|------|
| Thermal Resistance, Junction to Case | RAJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | RAIA | 200 | °C/W |

NPN 2N6515 thru 2N6517 PNP 2N6518 thru 2N6520

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

HIGH VOLTAGE TRANSISTOR

| | ELECTRICAL CHARAC | TERISTICS (TA = | 25°C unless otherwise noted.) |
|--|-------------------|-----------------|-------------------------------|
|--|-------------------|-----------------|-------------------------------|

| Characteristic | | Symbol | Min | Max | Unit |
|---|------------------------|-------------|-----|------------|----------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) | | V(BR)CEO | | | Vdc |
| (IC = 1.0 mAdc, IB = 0) | 2N6515, 2N6518 | , (bill)CEO | 250 | l <u> </u> | *** |
| | 2N6516, 2N6519 | ł l | 300 | l _ | |
| | 2N6517, 2N6520 | l l | 350 | _ | |
| Collector-Base Breakdown Voltage | | V(BR)CBO | | | Vdc |
| $(I_C = 100 \mu\text{Adc}, I_F = 0)$ | 2N6515, 2N6518 | - (BR)CBO | 250 | l _ | *** |
| - · · · · · | 2N6516, 2N6519 | | 300 | _ | |
| | 2N6517, 2N6520 | | 350 | _ | |
| Emitter-Base Breakdown Voltage | | V(BR)EBO | | | Vdc |
| (IE = 10 μAdc, IC = 0) | 2N6515, 2N6516, 2N6517 | (Brijebu | 6.0 | l | Vuc |
| | 2N6518, 2N6519, 2N6520 | | 5.0 | = | |
| Collector Cutoff Current | | Ісво | | | nAdc |
| (VCB = 150 Vdc, IF = 0) | 2N6515, 2N6518 | , CBO | _ | 50 | HAGE |
| (VCB = 200 Vdc, IE = 0) | 2N6516, 2N6519 | | | 50 | |
| (VCB = 250 Vdc, IE = 0) | 2N6517, 2N6520 | 1 | _ | 50 50 | ļ |
| Emitter Cutoff Current | <u> </u> | leng | | | - 4.4 |
| (VEB = 5.0 Vdc, IC = 0) | 2N6515, 2N6516, 2N6517 | IEBO | | | nAdc |
| (VEB = 4.0 Vdc, IC = 0) | 2N6518, 2N6519, 2N6520 | | _ | 50 50 | |
| ON CHARACTERISTICS(1) | | | | | <u> </u> |
| DC Current Gain | | hFE | | Γ | · |
| $(I_C = 1.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})$ | 2N6515, 2N6518 | | 35 | | _ |
| (C = 1.5 m. ads, VCE = 10 Vac) | 2N6516, 2N6519 | | 30 | _ | |
| | 2N6517, 2N6520 | | 20 | _ | |
| | | | 20 | _ | 1 |
| (I _C = 10 mAdc, V _{CE} = 10 Vdc) | 2N6515, 2N6518 | | 50 | _ | [|
| | 2N6516, 2N6519 | i | 45 | _ | Ī |
| | 2N6517, 2N6520 | | 30 | _ | |
| (lo = 20 mAde Von = 10 Vd-) | 0110545 0110545 | * . | | | |
| (I _C = 30 mAdc, V _{CE} = 10 Vdc) | 2N6515, 2N6518 | | 50 | 300 | |
| | 2N6516, 2N6519 | 1 1 | 45 | 270 | 1 |
| | 2N6517, 2N6520 | - 1 | 30 | 200 | |
| (I _C = 50 mAdc, V _{CE} = 10 Vdc) | 2N6515, 2N6518 | | 45 | 220 | |
| | 2N6516, 2N6519 | 1 | 40 | 200 | 1 |
| | 2N6517, 2N6520 | 1 | 20 | 100 | |
| #= 400 == A == 1 | | 1 1 | | | |
| (I _C = 100 mAdc, V _{CE} = 10 Vdc) | 2N6515, 2N6518 | | 25 | _ | |
| | 2N6516, 2N6519 |] [| 20 | _ | |
| | 2N6517, 2N6520 | | 15 | | |

NPN 2N6515 thru 2N6517, PNP 2N6518 thru 2N6520

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol VCE(sat) | Min — — — — — — — — — — — — — — — — — — — | 0.30 0.35 0.50 1.0 | Unit Vdc |
|--|-----------------------|---|-----------------------------|-------------|
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) (IC = 20 mAdc, Ig = 2.0 mAdc) (IC = 30 mAdc, Ig = 3.0 mAdc) (IC = 50 mAdc, Ig = 5.0 mAdc) | | | | |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) (IC = 20 mAdc, Ig = 2.0 mAdc) (IC = 30 mAdc, Ig = 3.0 mAdc) | V _{BE} (sat) | = | 0.75 0.85 0.90 | Vdc |
| Base-Emitter On Voltage (I _C = 100 mAdc, V _{CE} = 10 Vdc) | V _{BE(on)} | _ | 2.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product(1) (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 20 MHz) | ft | 40 | 200 | MHz |
| Collector-Base Capacitance (VCB = 20 Vdc, Ig = 0, f = 1.0 MHz) | C _{cb} | - | 6.0 | pF |
| Emitter-Base Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz) 2N6515 thru 2N6517 2N6518 thru 2N6520 | C _{eb} | | 80 100 | pF |
| SWITCHING CHARACTERISTICS | | | | |
| Turn-On Time (VCC = 100 Vdc, VBE(off) = 2.0 Vdc, I _C = 50 mAdc, I _{B1} = 10 mAdc) | t _{on} | _ | 200 | ns |
| Turn-Off Time (V _{CC} = 100 Vdc, I _C = 50 mAdc, I _{B1} = I _{B2} = 10 mAdc) | toff | _ | 3.5 | ns |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

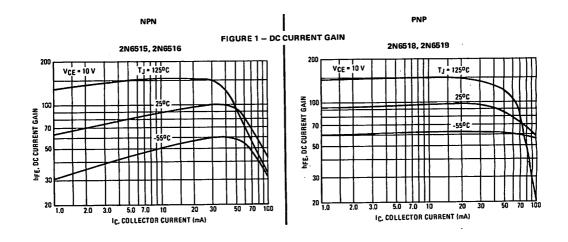
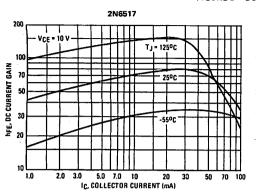


FIGURE 2 - DC CURRENT GAIN



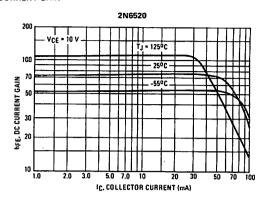
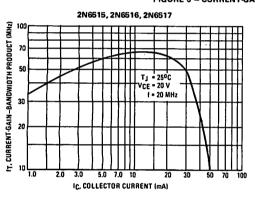
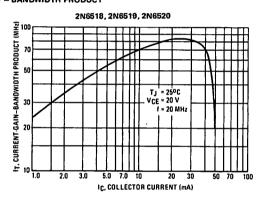
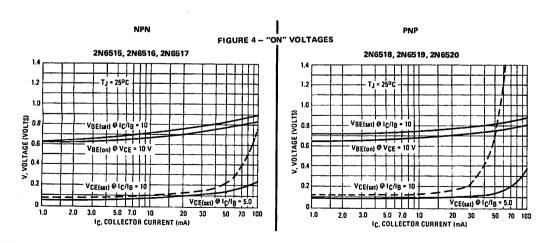
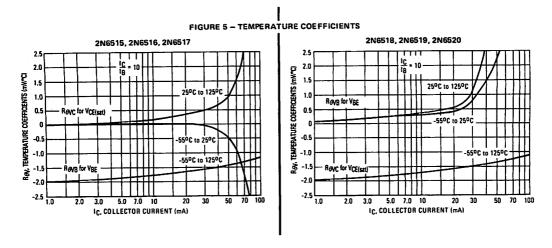


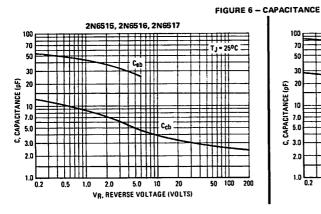
FIGURE 3 – CURRENT-GAIN – BANDWIDTH PRODUCT

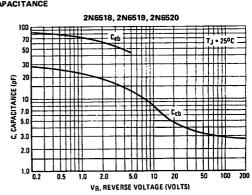


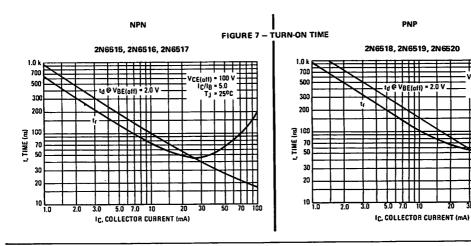












= 5.0

NPN 2N6515 thru 2N6517, PNP 2N6518 thru 2N6520

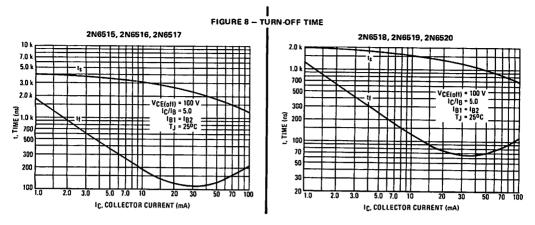
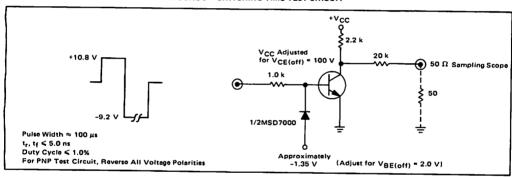
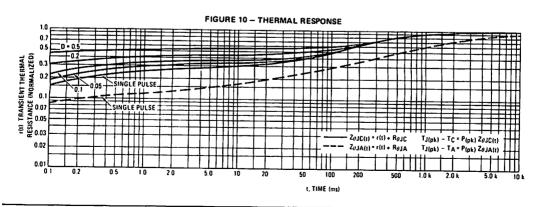
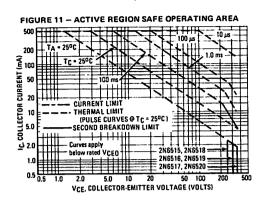


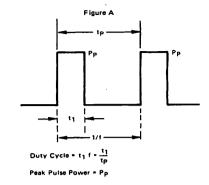
FIGURE 9 - SWITCHING TIME TEST CIRCUIT







DESIGN NOTE: USE OF TRANSIENT THERMAL RESISTANCE DATA



| Rating | Symbol | MPS404 | MPS404A | Unit |
|---|----------------------|------------|---------|----------------|
| Collector-Emitter Voltage | VCEO | 24 | 35 | Vdc |
| Collector-Base Voltage | VCBO | 25 | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 12 | 25 | Vdc |
| Collector Current — Continuous | l _C | 150 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | | mW mW/℃ |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | Tj, T _{stg} | -55 t | °C | |

THERMAL CHARACTERISTICS

| TTTETTE OF THE TOTAL OF THE TOT | | | |
|--|----------------------|------|------|
| Characteristic | Symbol | Max | Unit |
| Thermal Resistance, Junction to Case | ReJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 200 | °C/W |

⁽¹⁾ Raja is measured with the device soldered into a typical printed circuit board.

MPS404 MPS404A

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

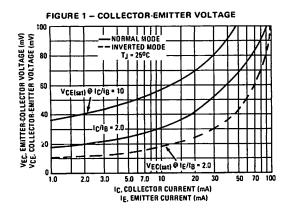
CHOPPER TRANSISTOR

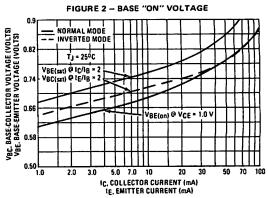
PNP SILICON

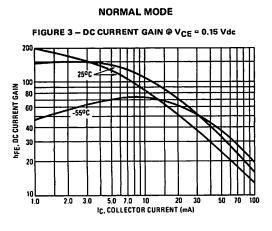
| ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherw | l haton asiv | |
|---|--------------|--|
|---|--------------|--|

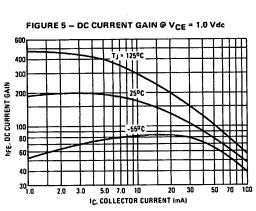
| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|-------------------|----------------------|----------|-------------|--------------|------|
| OFF CHARACTERISTICS | - | | | · | · | |
| Collector-Emitter Breakdown Voltage(2) (I _C = 10 mAdc, I _B = 0) | MPS404 MPS404A | V(BR)CEO | 24 35 | = | = | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | MPS404 MPS404A | V(BR)CBO | 25 40 | = | = | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | MPS404 MPS404A | V(BR)EBO | 12 25 | 50 50 | = | Vdc |
| Collector Cutoff Current (VCB = 10 Vdc, IE = 0) | | ІСВО | - | _ | 100 | nAdo |
| Emitter Cutoff Current (VBE = 10 Vdc, IC = 0) | | I _{EBO} | | | 100 | nAdo |
| ON CHARACTERISTICS | | | | | · | |
| DC Current Gain (IC = 12 mAdc, VCE = 0.15 Vdc) | | hFE | 30 | 100 | 400 | - |
| Collector-Emitter Saturation Voltage (IC = 12 mAdc, IB = 0.4 mAdc) (IC = 24 mAdc, IB = 1.0 mAdc) | | VCE(sat) | | 0.1 0.12 | 0.15 0.20 | Vdc |
| Base-Emitter Saturation Voltage (IC = 12 mAdc, IB = 0.4 mAdc) (IC = 24 mAdc, IB = 1.0 mAdc) | | V _{BE(sat)} | = | 0.7 0.74 | 0.85 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Common-Base Cutoff Frequency (IC = 1.0 mAdc, VCB = 6.0 Vdc) | | fob | 4.0 | _ | _ | MHz |
| Output Capacitance (VCB = 6.0 Vdc, IE = 0, f = 1.0 MHz) | | Cobo | | 6.8 | 20 | pF |

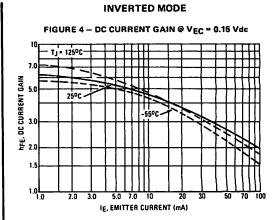
(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

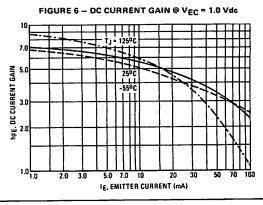




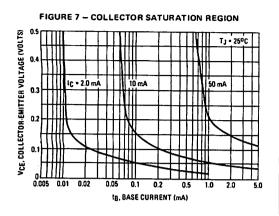


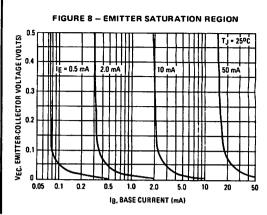






MPS404, MPS404A

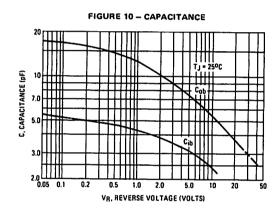


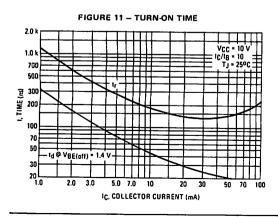


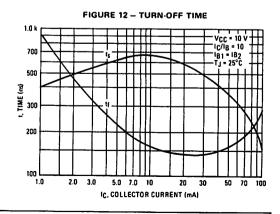
0.7 1.0

IB, BASE CURRENT (mA)

2.0 3.0 5.0 7.0







5.0

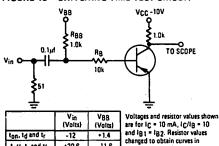
0.1

0.2 0.3

toff, ts and tf

+20.6

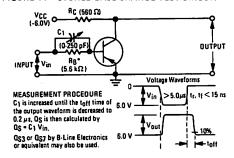
FIGURE 13 - SWITCHING TIME TEST CIRCUIT



-11.6

Figures 11 and 12.

FIGURE 14 - STORED BASE CHARGE TEST CIRCUIT



| WATER TO THE TOTAL TO THE TOTAL TOTA | | | | |
|--|-----------------------------------|------------------|------------------|---------------|
| Rating | Symbol | MPS650 MPS750 | MPS651 MPS751 | Unit |
| Collector-Emitter Voltage | VCEO | 40 | 60 | Vdc |
| Collector-Base Voltage | V _{CBO} | 60 | 80 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc |
| Collector Current — Continuous | lc | 2.0 | | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 12.0 | | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 5.0 | | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 55 to | + 150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------|------|
| Thermal Resistance, Junction to Case | RøJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | RAIA | 200 | °C/W |

MPS650 MPS651 NPN SILICON

MPS750 MPS751 PNP SILICON

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

| Characteristi | ic | Symbol | Min | Max | Unit |
|--|----------------------------------|----------------------|----------------------|-------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | MPS650, MPS750 MPS651, MPS751 | V(BR)CEO | 40 60 | = | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μAdc, IE = 0) | MPS650, MPS750 MPS651, MPS751 | V(BR)CBO | 60 80 | = | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 60 Vdc, IE = 0) (VCB = 80 Vdc, IE = 0) | MPS650, MPS750 MPS651, MPS751 | СВО | - | 0.1 0.1 | μAdc |
| Emitter Cutoff Current (VEB = 4.0 V, IC = 0) | | IEBO | _ | 0.1 | μAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain (I _C = 50 mA, V _{CE} = 2.0 V) (I _C = 500 mA, V _{CE} = 2.0 V) (I _C = 1.0 A, V _{CE} = 2.0 V) (I _C = 2.0 A, V _{CE} = 2.0 V) | | pFE | 75 75 75 40 | _ _ _ | |
| Collector-Emitter Saturation Voltage (I _C = 2.0 A, I _B = 200 mA) (I _C = 1.0 A, I _B = 100 mA) | | VCE(sat) | | 0.5 0.3 | Vdc |
| Base-Emitter Saturation Voltage (IC = 1.0 A, IB = 100 mA) | | V _{BE(sat)} | - | 1.2 | Vdc |
| Base-Emitter On Voltage (IC = 1.0 A, VCE = 2.0 V) SMALL-SIGNAL CHARACTERISTICS | | V _{BE(on)} | - | 1.0 | Vdc |
| | | | | т | |
| Current-Gain — Bandwidth Product(2) (IC = 50 mAdc, VCE = 5.0 Vdc, f = 100 MHz) | | ft | 75 | | MHz |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

⁽²⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.

MPS706,A

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| WANTED TO THE TOTAL TOTA | | | |
|--|-----------------------------------|-------------|---------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCER | 20 | Vdc |
| Collector-Base Voltage | VCBO | 25 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 200 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|----------------------|------|------|
| Thermal Resistance, Junction to Case | RøJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 200 | °C/W |

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|---------------------------|------------------|----------|------------|------------|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, IB = 0) | | V(BR)CEO | 15 | _ | _ | Vdc |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, RBE = 10 Ohms) | | V(BR)CER | 20 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0) | | V(BR)CBO | 25 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 μAdc, IC = 0) | | V(BR)EBO | 5.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) (VCB = 25 Vdc, IE = 0) | MPS706/MPS706A MPS706A | ICBO | 11 | - | 0.5 10 | μAdc |
| Collector Cutoff Current (VCE = 20 Vdc, RBE = 100 kHz) | MPS706A | ICER | 1 | _ | 10 | μAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, I_C = 0) (VBE = 5.0 Vdc, I_C = 0) | MPS706 MPS706A | 1 _{EBO} | - | _ | 10 10 | μAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain(2) (I _C = 10 mAde, V _{CE} = 1.0 Vdc) | MPS706 MPS706A | hFE | 20 20 | 50 45 | 60 | - |
| Collector-Emitter Saturation Voltage(2) (IC = 10 mAdc, Ig = 1.0 mAdc) | | VCE(sat) | _ | 0.3 | 0.6 | Vdc |
| Base-Emitter Saturation Voltage(2) (IC = 10 mAdc, I _B = 1.0 mAdc) | MPS706 MPS706A | VBE(sat) | 0.7 | 0.8 0.8 | 0.9 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 15 Vdc, f = 100 MHz) | | fτ | 200 | 600 | | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | MPS706 | Cobo | _ | 1.5 | 6.0 | pF |
| Input Capacitance (VBE = 1.0 Vdc, I _C = 0, f = 100 kHz) | | C _{ibo} | _ | 3.4 | _ | pF |
| Extrinsic Base Resistance (VCF = 15 Vdc, IE = 10 mAdc, f = 300 MHz) | | rЬ | - | - | 50 | pF |

MPS706,A

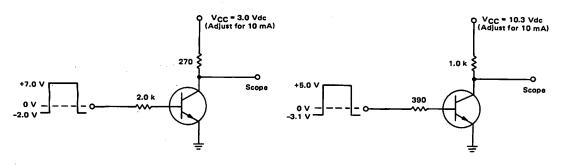
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|-----------------------------|--------|-----|----------|----------|---------|
| SWITCHING CHARACTERISTICS | | • | | | | |
| Storage Time (Figure 1) (VCC = 10 Vdc, I _C = 10 mAdc, I _{B1} = I _{B2} = 10 mAdc) | MPS706A MPS706 | ts | = | 20 20 | 25 60 | ns |
| Turn-On Time (Figure 1) (VCC = 3.0 Vdc, VBE(off) = 2.0 Vdc, I_C = 10 mAdc, | l _{B1} = 3.0 mAdc) | ton | _ | 35 | 40 | ns |
| Turn-Off Time (Figure 2) ($V_{CC} = 3.0 \text{ Vdc}$, $I_{C} = 10 \text{ mAdc}$, $I_{B1} = I_{B2} = 3.0 \text{ mA}$ | Adc) | toff | _ | 55 | 75 | ns |

⁽¹⁾ Raja is measured with the device soldered into a typical printed circuit board. (2) Pulse Test: Pulse Width \leq 12 ns, Duty Cycle \leq 2.0%.

FIGURE 1 - SWITCHING TIME TEST CIRCUIT

FIGURE 2 - STORAGE TIME TEST CIRCUIT



CASE 29-02, STYLE 1 TO-92 (TO-226AA)

SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|--------------|---------------|
| Collector-Emitter Voltage | VCEO | 15 | Vdc |
| Collector-Base Voltage | V _{CBO} | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 200 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 mW | Watt mW/°C |
| Operating and Storage Junction Temperature Range | TJ, Tstg | -55 to +150 | ů |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|----------------------|------|------|
| Thermal Resistance, Junction to Case | Rejc | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 200 | •c/w |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

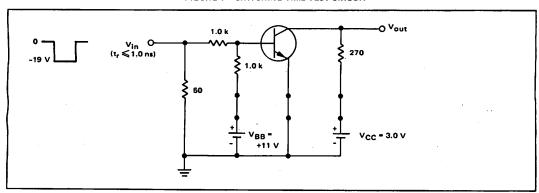
| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------------------|----------|----------|----------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 30 mAdc, Ig = 0) | V(BR)CEO | 15 | | _ | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 30 mAdc, RgE = 10 Ohms) | V(BR)CER | 20 | _ | - | Vdc |
| Collector-Base Breakdown Voltage (I _C = 1.0 µAdc, I _E = 0) | V(BR)CBO | 40 | _ | - | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | V(BR)EBO | 5.0 | _ | | Vdc, |
| Collector Cutoff Current (VCB = 20 Vdc, IE = 0) | ICBO | _ | _ | 25 | nAdc |
| Emitter Cutoff Current (VBF = 4.0 Vdc, IC = 0) | IEBO | _ | _ | 80 | nAdc |
| ON CHARACTERISTICS(2) | | | | | |
| DC Current Gain (I _C = 0.5 mAdc, V _{CE} = 1.0 Vdc) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) | hee | 15 30 | 35 50 | _ 120 | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | VCE(sat) | _ | 0.21 | 0.4 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | V _{BE(sat)} | 0.68 | 0.7 | 0.78 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | fT | 300 | 600 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, Ig = 0, f = 140 kHz) | C _{obo} | _ | 2.4 | 6.0 | pF |
| SWITCHING CHARACTERISTICS | | | | | |
| Storage Time (Figure 1) $(V_{CC} = 3.0 \text{ Vdc}, I_{C} = 10 \text{ mAdc}, I_{B1} = I_{B2} = 10 \text{ mAdc})$ | t _S | | 14 | 25 | ns |

R_{BJA} is measured with the device soldered into a typical printed circuit board.
 Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MPS750, MPS751

For Sepcifications, See MPS650, MPS651

FIGURE 1 - SWITCHING TIME TEST CIRCUIT



CASE 29-02, STYLE 1 TO-92 (TO-226AA)

SWITCHING TRANSISTOR

NPN SILICON

MAYIMI IM DATINGS

| MAXIMUM RATINGS | | | |
|---|-----------------------------------|-------------|---------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 30 | Vdc |
| Collector-Base Voltage | VCBO | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 200 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +150 | ဗ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | Raja(1) | 200 | •cw |

| Characteristic | | Min | Тур | Max | Unit |
|--|----------------------|-----|------------|--------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Base Breakdown Voltage (I _C = 10 µAdc, I _E = 0) | V(BR)CBO | 40 | | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | - | Vdc |
| Collector Cutoff Current (VCB = 20 Vdc, IE = 0) | ІСВО | _ | _ | 0.5 | μAdc |
| Collector Cutoff Current (VCE = 30 Vdc, VBE = 0) | ICES | _ | | 10 | μAdc |
| ON CHARACTERISTICS | | | , | , | |
| DC Current Gain(2) (IC = 10 mAdc, VCE = 1.0 Vdc) | hFE | 25 | | _ | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc)(2) | VCE(sat) | _ | 0.2 0.3 | 0.25 0.4 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | V _{BE(sat)} | _ | 0.7 | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | , | , | |
| Current-Gain — Bandwidth Product(2) (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz) | fT | 350 | 600 | | MHz |
| Output Capacitance (VCB = 10 Vdc, Ig = 0, f = 100 kHz) | C _{obo} | _ | 1.5 | 4.0 | pF |
| Input Capacitance (VEB = 10 Vdc, IC = 0, f = 100 kHz) | C _{ibo} | _ | 3.4 | - | pF |
| SWITCHING CHARACTERISTICS | | | | | |
| Storage Time (Figure 1) (VCC = 10 Vdc, I _C = 10 mAdc, I _{B1} = I _{B2} = 10 mAdc) | t _S | _ | 18 | 25 | ns |
| Turn-On Time (Figure 1) (VCC = 3.0 Vdc, VBE(off) = 4.0 Vdc, IC = 10 mAdc, IB1 = 3.0 mAdc) | ton | _ | 12 | 16 | ns |
| Turn-Off Time (Figure 2) (V _{CC} = 3.0 Vdc, I _C = 10 mAdc, I _{B1} = 3.0 mAdc) | ^t off | | 25 | 30 | ns |

⁽¹⁾ R_{6JA} is measured with the device soldered into a typical printed circuit board. (2) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

FIGURE 1 - SWITCHING TIME TEST CIRCUIT

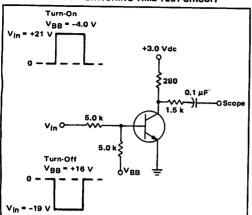
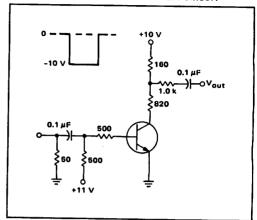


FIGURE 2 - STORAGE TIME TEST CIRCUIT



CASE 29, STYLE 1 TO-92 (TO-226AA)

SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MINVINOM UNTINGO | | | |
|--|-----------------------------------|-------------|---------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Base Voltage | V _{CBO} | 25 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | lc | 200 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | . PD | 1.5 12 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| TILLINIAE OFFICE CONTRACTOR | | | |
|---|------------------|------|------|
| Characteristic | Symbol | Max | Unit |
| Thermal Resistance, Junction to Case | R _{ØJC} | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | ReJA(1) | 200 | •c\w |

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|----------------------|-----|------|------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 25 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | V(BR)EBO | 3.0 | - | | Vdc |
| Collector Cutoff Current (VCB = 20 Vdc, IE = 0) | ІСВО | | _ | 0.5 | μAdc |
| Collector Cutoff Current (VCF = 20 Vdc, VBF = 0) | ICES | | | 10 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain {Ic = 10 mAdc, VcE = 1.0 Vdc} | hFE | 20 | 35 | - | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | VCE(sat) | | 0.20 | 0.30 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | V _{BE(sat)} | _ | 0.78 | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gein — Bandwidth Product(2) (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 100 MHz) | fT | 300 | 600 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | C _{obo} | | 1.5 | 4.0 | pF |
| SWITCHING CHARACTERISTICS | | | | | |
| Storage Time (Figure 1) (VCC = 10 V, I _C = 10 mAdc, I _{B1} = I _{B2} = 10 mAdc) | t _S | _ | 28 | 35 | ns |
| Turn-On Time (Figure 2) (VCC = 3.0 V, VBE(off) = 2.0 V, I _C = 10 mAdc, I _{B1} = 3.0 mAdc, I _{B2} = 1.0 mAdc) | ton | _ | 15 | 20 | ns |
| Turn-Off Time (Figure 2) (V _{CC} = 3.0 V, l _C = 10 mAdc, l _{B1} = 3.0 mA, l _{B2} = 1.0 mAdc) | ^t off | | 30 | 35 | ns |

⁽¹⁾ R_{6JA} is measured with the device soldered into a typical printed circuit board. (2) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

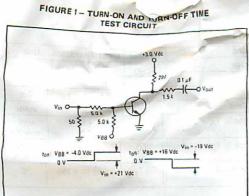
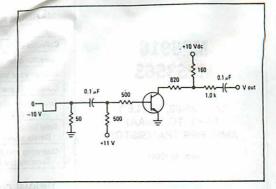


FIGURE 2 - STORAGE TIME TEST CIRCUIT



MPS918 MPS3563

CASE 29-02, STYLE 1 TO-92 (TO-226AA) AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | MPS918 | MPS3563 | Unit |
|---|----------------------|------------|---------|---------------|
| Collector-Emitter Voltage | VCEO | 15 | 12 | Vdc |
| Collector-Base Voltage | VCBO | 30 | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | 2.0 | Vdc |
| Collector Current — Continuous | IC | 50 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | | Watt mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 t | o +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|----------------------|------|------|
| Thermal Resistance, Junction to Case | R _B JC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{EJA} (1) | 200 | °C/W |

| Characteristic | | Symbol | Min | Max | Unit |
|---|-----------------------------|-----------------------|------------|-------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 3.0 mAdc, IB = 0) | MPS918 MPS3563 | V(BR)CEO | 15 12 | = | Vdc |
| Collector-Base Breakdown Voltage $(I_C = 1.0 \ \mu Adc, I_E = 0)$ $(I_C = 100 \ \mu Adc, I_E = 0)$ | MPS918 MPS3563 | V _(BR) CBO | 30 30 | _ | Vdc |
| Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc$, $I_C = 0$) | MPS918 MPS3563 | V _{(BR)EBO} | 3.0 2.0 | Ξ | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, I _E = 0) | MPS918 MPS3563 | СВО | _ | 10 50 | nAdc |
| ON CHARACTERISTICS | 7,000,00 | | | | |
| DC Current Gain(2) (IC = 3.0 mAdc, VCE = 1.0 Vdc) (IC = 8.0 mAdc, VCE = 10 Vdc) | MPS918 | hFE | 20 20 | _ 200 | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | MPS918 | V _{CE(sat)} | - | 0.4 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | MPS918 | V _{BE(sat)} | - | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product(2) $\{I_C = 4.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, f = 100 \text{ MHz}\}$ $\{I_C = 8.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, f = 100 \text{ MHz}\}$ | MPS918 MPS3563 | fT | 600 600 | 1500 | MHz |
| Output Capacitance (VCB = 0 Vdc, IE = 0, f = 140 kHz) (VCB = 10 Vdc, IE = 0, f = 140 kHz) (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | MPS918 MPS918 MPS3563 | C _{obo} | = | 3.0 1.7 1.7 | pF |
| Input Capacitance (VEB = 0.5 Vdc, IC = 0, f = 140 kHz) | MPS918 | C _{ibo} | _ | 2.0 | pF |
| Small-Signal Current Gain (IC = 8.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | MPS3563 | h _{fe} | 20 | 250 | - |
| Noise Figure (I _C = 1.0 mAdc, V_{CE} = 6.0 Vdc, R_S = 400 ohms, f = 60 MHz) | MPS918 | NF | _ | 6.0 | dB |

MPS918, MPS3563

| Characteristic | | Symbol | Min | Max | Unit |
|--|-------------------|-----------------|----------|-----|------|
| FUNCTIONAL TEST | | | | | - |
| Common-Emitter Amplifier Power Gain (I _C = 6.0 mAdc, V _{CB} = 12 Vdc, f = 200 MHz) (I _C = 8.0 mAdc, V _{CE} = 10 Vdc, f = 200 MHz) (G _{fd} + G _{fe} < -20 dB) | MPS918 MPS3563 | G _{pe} | 15 14 | = | dB |
| Power Output (I _C = 8.0 mAdc, V _{CB} = 15 Vdc, f = 500 MHz) | MPS918 | Pout | 30 | - | mW |
| Oscillator Collector Efficiency (I _C = 8.0 mAdc, V_{CB} = 15 Vdc, P_{Out} = 30 mW, f = 500 MHz) | MPS918 | η | 25 | | % |

⁽¹⁾ R_{ØJA} is measured with the device soldered into a typical printed circuit board. (2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 1.0%.

MPS929,A MPS930,A

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | MPS929 MPS930 | MPS929A MPS930A | Unit |
|---|-----------------------------------|------------------|--------------------|----------------|
| Collector-Emitter Voltage | VCEO | | 45 | Vdc |
| Collector-Base Voltage | VCBO | 45 | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | 6.0 | Vdc |
| Collector Current — Continuous | lc | 100 | | mAdc |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 625 5.0 | | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | | ో |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 83.3 | .cw |
| Thermal Resistance, Junction to Ambient | Raja | 200 | °C/W |

Refer to MPS3903 for additional graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

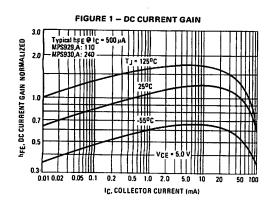
| Characteristic | | Symbol | Min | Max | Unit |
|--|--|----------|----------------------|-------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, Ig = 0) | | V(BR)CEO | 45 | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 μAdc, IE = 0) | MPS929, MPS930 MPS929A, MPS930A | V(BR)CBO | 45 60 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | MPS929, MPS930 MPS929A, MPS930A | V(BR)EBO | 5.0 6.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 5.0 Vdc, IB = 0) | | ICEO | - | 2.0 | nAdc |
| Collector Cutoff Current (VCB = 45 Vdc, I _E = 0) | MPS929, MPS930 MPS929A, MPS930A | ICBO | _ | 10 2.0 | nAdc |
| Collector Cutoff Current (VCE = 45 Vdc, VBE = 0) | MPS929, MPS930 MPS929A, MPS930A | ICES | _ | 10 2.0 | nAdc |
| $(V_{CE} = 45 \text{ Vdc}, V_{BE} = 0, T_A = 125^{\circ}C)$ | MPS929, MPS930 MPS929A, MPS930A | | | 10 \ 2.0 | μAdc |
| Emitter Cutoff Current (VEB = 6.0 Vdc, IC = 0) | MPS929, MPS930 MPS929A, MPS930A | IEBO | | 10 2.0 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(1) (I _C = 1.0 μAdc, V _{CE} = 5.0 Vdc) | MPS929A MPS930A | pŁE | 25 60 | _ | _ |
| (I _C = 10 µAdc, V _{CE} = 5.0 Vdc) | MPS929, MPS929A MPS930, MPS930A | | 40 100 | 120 300 | |
| $(I_C = 10 \mu\text{Adc}, V_{CE} = 5.0 \text{Vdc}, T_A = -55^{\circ}\text{C})$ | MPS929 MPS929A MPS930 MPS930A | | 10 15 20 30 | = | |
| (I _C = 500 μAdc, V _{CE} = 5.0 Vdc) | MPS929, MPS929A MPS930, MPS930A | | 60 150 | = | |
| (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) | MPS929, MPS929A MPS930, MPS930A | | | 350 600 | |

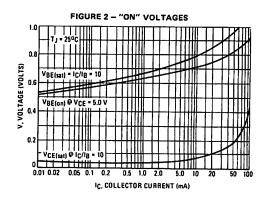
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

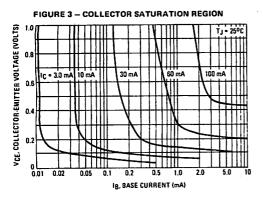
| Characteristic | | Symbol | Min | Max | Unit |
|---|------------------------------------|----------------------|------------|------------|--------|
| Collector-Emitter Saturation Voltage(1) (IC = 10 mAdc, IB = 0.5 mAdc) | MPS929, MPS930 MPS929A, MPS930A | VCE(sat) | = | 1.0 0.5 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 10 mAdc, IB = 0.5 mAdc) | MPS929, MPS930 MPS929A, MPS930A | V _{BE(sat)} | 0.6 0.7 | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | - |
| Current-Gain — Bandwidth Product (I _C = 500 μAdc, V _{CE} = 5.0 Vdc, f = 30 MHz) | MPS929, MPS930 MPS929A, MPS930A | fΤ | 30 45 | _ | MHz |
| Output Capacitance (VCB = 5.0 Vdc, Ig = 0, f = 1.0 MHz) | MPS929, MPS930 MPS929A, MPS930A | Cobo | = | 8.0 6.0 | pF |
| Input Impedance (Ig = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) | | hib | 25 | 32 | Ohms |
| Voltage Feedback Ratio (I _E = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) | | h _{rb} | _ | 600 | X 10-6 |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | MPS929, MPS929A MPS930, MPS930A | h _{fe} | 60 150 | 350 600 | _ |
| Output Admittance (IE = 1.0 mAdc, VCB = 5.0 Vdc, f = 1.0 kHz) | | h _{ob} | _ | 1.0 | μmho |
| Noise Figure (IC = 10 μAdc, VCE = 5.0 Vdc, RS = 10 kohms, f = 10 Hz to 15.7 kHz) | MPS929, MPS929A MPS930, MPS930A | NF | = | 4.0 3.0 | dB |

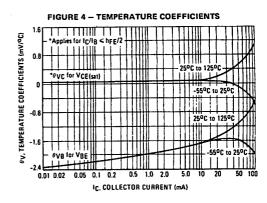
⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

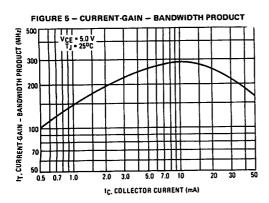
TYPICAL CHARACTERISTICS

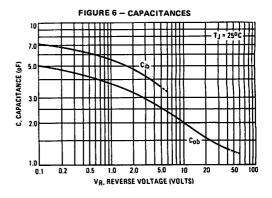












| Rating | Symbol | MPS2222 | MPS2222A | Unit |
|---|-----------------------------------|---------------|----------|----------------|
| Collector-Emitter Voltage | VCEO | 30 | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 60 | 75 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | 6.0 | Vdc |
| Collector Current — Continuous | lc | 600 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 55 to + 150 | | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------|------|
| Thermal Resistance, Junction to Case | RøJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | Raja | 200 | °C/W |

MPS2222 MPS2222A*

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

| Characteristic | | Symbol | Min | Max | Unit |
|---|--|----------|---|--------------------------|------|
| OFF CHARACTERISTICS | | | * | | |
| Collector-Emitter Breakdown Voltage (IC = 10 mAdc, IB = 0) | MPS2222 MPS2222A | V(BR)CEO | 30 40 | = | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | MPS2222 MPS2222A | V(BR)CBO | 60 75 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 μAdc, IC = 0) | MPS2222 MPS2222A | V(BR)EBO | 5.0 6.0 | = | Vdc |
| Collector Cutoff Current (VCE = 60 Vdc, VEB(off) = 3.0 Vdc) | MPS2222A | ICEX | | 10 | nAdo |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) (VCB = 60 Vdc, IE = 0) (VCB = 50 Vdc, IE = 0, TA = 125°C) (VCB = 50 Vdc, IE = 0, TA = 125°C) | MPS2222 MPS2222A MPS2222 MPS2222A | ICBO | = = = | 0.01 0.01 10 10 | μAdo |
| Emitter Cutoff Current (VEB = 3.0 Vdc, I _C = 0) | MPS2222A | IEBO | _ | 10 | nAdo |
| Base Cutoff Current (VCE = 60 Vdc, VEB(off) = 3.0 Vdc) ON CHARACTERISTICS | MPS2222A | IBL | _ | 20 | nAdc |
| DC Current Gain (IC = 0.1 mAdc, VCE = 10 Vdc) (IC = 1.0 mAdc, VCE = 10 Vdc) (IC = 10 mAdc, VCE = 10 Vdc) (IC = 10 mAdc, VCE = 10 Vdc) (IC = 150 mAdc, VCE = 10 Vdc)(1) (IC = 150 mAdc, VCE = 1.0 Vdc)(1) (IC = 500 mAdc, VCE = 1.0 Vdc)(1) | MPS2222A only MPS2222 MPS2222A | hFE | 35 50 75 35 100 50 30 40 | 300 | _ |
| Collector-Emitter Saturation Voltage(1) (IC = 150 mAdc, IB = 15 mAdc) | MPS2222 MPS2222A | VCE(sat) | | 0.4 0.3 | Vdc |
| (IC = 500 mAdc, IB = 50 mAdc) | MPS2222 MPS2222A | | _ | 1.6 1.0 | |

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|---|---------------------|----------------------|---------|------------|------|
| Base-Emitter Saturation Voltage(1) (I _C = 150 mAdc, I _B = 15 mAdc) | MPS2222 MPS2222A | V _{BE(sat)} | 0.6 | 1.3 1.2 | Vdc |
| (IC = 500 mAdc, IB = 50 mAdc) | MPS2222 MPS2222A | | | 2.6 2.0 | |

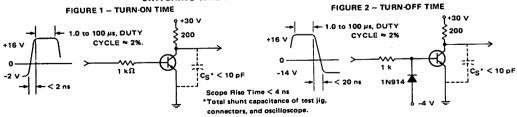
| SMALL-SIGNAL CHARACTERISTICS Current-Gain — Bandwidth Product(2) | | fr | | | MHz |
|--|----------------------|-------------------|-------------|-------------|--------|
| (IC = 20 mAdc, VCE = 20 Vdc, f = 100 MHz) | MPS2222 MPS2222A | | 250 300 | _ | |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | | C _{obo} | _ | 8.0 | pF |
| (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | MPS2222 MPS2222A | C _{ibo} | _ | 30 25 | pF |
| Input Impedance (IC = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) (IC = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | MPS2222A MPS2222A | h _{ie} | 2.0 0.25 | 8.0 1.25 | kΩ |
| Voltage Feedback Ratio (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) (IC = 10 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | MPS2222A MPS2222A | h _{re} | = | 8.0 4.0 | X 10-4 |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) (IC = 10 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | MPS2222A MPS2222A | h _{fe} | 50 75 | 300 375 | _ |
| Output Admittance (IC = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) (IC = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | MPS2222A MPS2222A | h _{oe} | 5.0 25 | 35 200 | μmhos |
| Collector Base Time Constant (I _E = 20 mAdc, V _{CB} = 20 Vdc, f = 31.8 MHz) | MPS2222A | rb'C _C | - | 150 | ps |
| Noise Figure (I _C = 100 μ Adc, V _{CE} = 10 Vdc, R _S = 1.0 k Ω , f = 1.0 kHz) | MPS2222A | NF | 4.0 | 4.0 | ₫B |

SWITCHING CHARACTERISTICS MPS2222A only

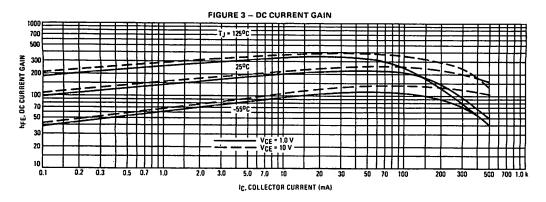
| Delay Time | (VCC = 30 Vdc, VBE(off) = 0.5 Vdc, | td | _ | 10 | ns |
|--------------|---|----------------|---|-----|----|
| Rise Time | IC = 150 mAdc, IB1 = 15 mAdc) (Figure 1) | t _r | - | 25 | ns |
| Storage Time | (V _{CC} = 30 Vdc, I _C = 150 mAdc, | tg | - | 225 | ns |
| Fall Time | I _{B1} = I _{B2} = 15 mAdc) (Figure 2) | tf | _ | 60 | ns |

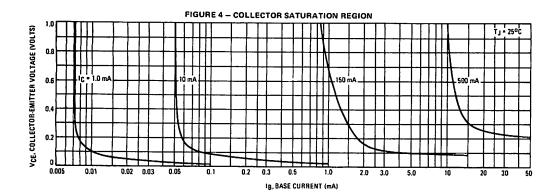
⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

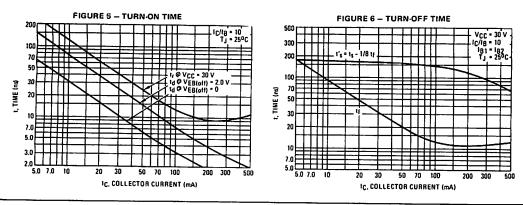
SWITCHING TIME EQUIVALENT TEST CIRCUITS

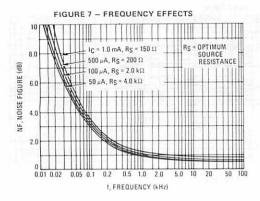


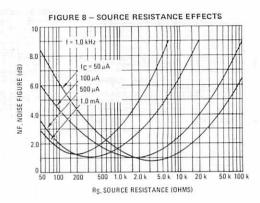
⁽²⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.

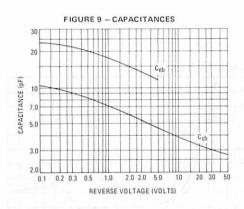


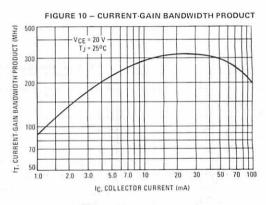


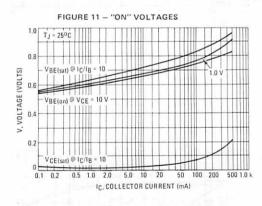


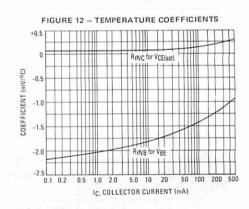












| Rating | Symbol | Value | Unit |
|---|------------------|-------------|-------------|
| Collector-Emitter Voltage | VCEO | 15 | Vdc |
| Collector-Emitter Voltage | VCES | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 4.5 | Vdc |
| Collector Current — Continuous | lc | 500 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Operating and Storage Junction Temperature Range | TJ, Tstg | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|-----|------|
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 200 | °C/W |

MPS2369

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

SWITCHING TRANSISTOR

NPN SILICON

| FI FCTRICAL | CHARACTERISTICS IT. | - 25°C unl | acc chlorules seed t |
|-------------|---------------------|------------|----------------------|

| Symbol | Min | Тур | Max | Unit |
|----------------------|---|--|--|--|
| | | <u> </u> | | |
| V(BR)CEO | 15 | _ | _ | Vdc |
| V(BR)CES | 40 | _ | _ | Vdc |
| V(BR)CBO | 40 | _ | _ | Vdc |
| V(BR)EBO | 4.5 | _ | _ | Vdc |
| ІСВО | 1 - | - | 0.4 30 | μAdc |
| | | | | |
| hfE | 40 20 20 | = | 120 — | _ |
| V _{CE(sat)} | _ | | 0.25 | Vdc |
| V _{BE(sat)} | 0.70 | _ | 0.85 | Vdc |
| <u> </u> | | | | |
| C _{obo} | _ | _ | 4.0 | pF |
| hfe | 5.0 | _ | _ | _ |
| | | | | |
| t _s | _ | 5.0 | 13 | ns |
| ton | _ | 8.0 | 12 | ns |
| ^t off | _ | 10 | 18 | ns |
| | V(BR)CEO V(BR)CES V(BR)CBO V(BR)EBO ICBO ICBO hFE VCE(sat) VBE(sat) Cobo hfe ts ton | V(BR)CEO 15 V(BR)CES 40 V(BR)CBO 40 V(BR)EBO 4.5 ICBO — — — hFE 40 20 20 VCE(sat) — VBE(sat) 0.70 Cobo — hfe 5.0 ts — ton — | V(BR)CEO 15 — V(BR)CES 40 — V(BR)CBO 40 — V(BR)EBO 4.5 — ICBO — — — hFE 40 — 20 — 20 — VCE(sat) — — VBE(sat) 0.70 — Cobo — — hfe 5.0 — ton — 8.0 | V(BR)CEO 15 — — V(BR)CES 40 — — V(BR)CBO 40 — — V(BR)EBO 4.5 — — ICBO — — 0.4 — — 30 PRESENTING PRESENTANCE PRESENTANC |

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

*Total shunt capacitance of test jig and connectors.

| Rating | Symbol | Value | Unit |
|---|----------------------|-------------|---------------|
| Collector-Emitter Voltage | VCEO | 18 | Vdc |
| Collector-Base Voltage | V _{CBO} | 18 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | l _C | 200 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12.0 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|----------------------|-----|------|
| Thermal Resistance, Junction to Case | RAJC | 125 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 357 | °C/W |

⁽¹⁾ Raja is measured with the device soldered into a typical printed circuit board.

MPS2714

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

SWITCHING TRANSISTOR

· NPN SILICON

| | Characteristic | Symbol | Min | Тур | Max | Unit |
|---|--|----------------------|-----|-------------|-----|-------------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakd | | V(BR)CEO | 18 | - | _ | V |
| Collector Cutoff Current (VCB = 18.0 Vdc, I _E = | 0) | ICBO | _ | - | 0.5 | μА |
| Emitter Cutoff Current (VBE = 5.0 Vdc, I _C = | 0) | IEBO | _ | _ | 0.5 | μА |
| ON CHARACTERISTICS | | | | | • | |
| DC Current Gain (IC = 2.0 mAdc, VCE = | = 4.5 Vdc) | hFE | 75 | _ | 225 | _ |
| Collector-Emitter Saturat (IC = 50 mAdc, IB = 3 | | V _{CE(sat)} | _ | - | 0.3 | Vdc |
| Base-Emitter Saturation (IC = 50 mAdc, IB = 3 | | V _{BE(sat)} | | _ | 1.3 | Vdc |
| SMALL-SIGNAL CHARAC | CTERISTICS | | | | | L |
| Current-Gain — Bandwid (IC = 10 mAdc, VCE = | th Product 10 Vdc, f = 100 MHz) | fτ | _ | 250 | - | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0 |), f = 100 kHz) | C _{obo} | _ | 2.5 | _ | pF |
| Input Impedance (IC = 0.5 mAdc, VCE = | = 1.0 Vdc, f = 1.0 kHz) | hie | _ | 3000 | _ | ohms |
| Small-Signal Current Gai (IC = 2.0 mAdc, VCE = | | h _{fe} | 80 | | 300 | - |
| SWITCHING CHARACTE | RISTICS | | | | - | |
| Delay Time | //- 10 A /- 20 A /- 10 -// | t _d | _ | 7.0 | _ | ns |
| Rise Time | (I _C = 10 mA, I _{B1} = 3.0 mA, V _{CC} = 10 V) | tr | _ | 6.0 | | ns |
| Storage Time | (IC = 10 mA, IB1 = 3.0 mA, IB2 = 1.0 mA, | ts | _ | 12 | _ | ns |
| Fall Time | V _{CC} = 10 V) | tf | | 9.0 | | ns |

MPS2907 MPS2907A

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| INDAMINON INTINGO | | | | |
|---|-----------------------------------|---------|------------|----------------|
| Rating | Symbol | MPS2907 | MPS2907A | Unit |
| Collector-Emitter Voltage | VCEO | 40 | 60 | Vdc |
| Collector-Base Voltage | VCBO | | 60 | Vdc |
| Emitter-Base Voltage | VEBO | | 5.0 | Vdc |
| Collector Current — Continuous | łc | | 600 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 4 | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 55 | to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------|------|
| Thermal Resistance, Junction to Case | RøJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | Reja | 200 | °C/W |

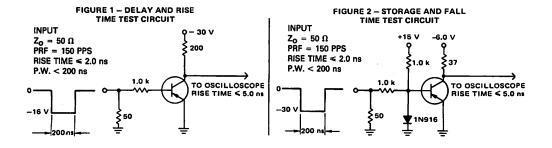
| Characteris | tic | Symbol | Min | Max | Unit |
|---|---------------------|----------------------|-----------|----------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | MPS2907 MPS2907A | V(BR)CEO | 40 60 | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | | V(BR)CBO | 60 | - | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 30 Vdc, VBE(off) = 0.5 Vdc) | | ICEX | _ | 50 | nAdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) | MPS2907 MPS2907A | СВО | _ | 0.020 0.010 | μAdc |
| (V _{CB} = 50 Vdc, I _E = 0, T _A = 125°C) | MPS2907 MPS2907A | | | 20 10 | |
| Base Current (VCE = 30 Vdc, VBE(off) = 0.5 Vdc) | | lΒ | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | | · |
| DC Current Gain (IC = 0.1 mAdc, V _{CE} = 10 Vdc) | MPS2907 MPS2907A | pŁE | 35 75 | = | _ |
| (IC = 1.0 mAdc, V_{CE} = 10 Vdc) | MPS2907 MPS2907A | | 50 100 | = | |
| (IC = 10 mAdc, V_{CE} = 10 Vdc) | MPS2907 MPS2907A | | 75 100 | = | |
| (IC = 150 mAdc, VCE = 10 Vdc)(1) | MPS2907, MPS2907A | | 100 | 300 | ĺ |
| (IC = 500 mAdc, VCE = 10 Vdc)(1) | MPS2907 MPS2907A | | 30 50 | | |
| Collector-Emitter Saturation Voltage(1) (I _C = 150 mAdc, I _B = 15 mAdc) (I _C = 500 mAdc, I _B = 50 mAdc) | | VCE(sat) | = | 0.4 1.6 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 150 mAdc, Ig = 15 mAdc) (IC = 500 mAdc, Ig = 50 mAdc) | | V _{BE(sat)} | = | 1.3 2.6 | Vdc |

MPS2907, MPS2907A

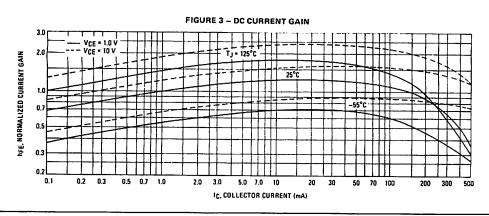
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| | Characteristic | Symbol | Min | Max | Unit |
|---|---|------------------|-----|-------------|------|
| SMALL-SIGNAL CH | ARACTERISTICS | | | | |
| | iwidth Product(1),(2) CE = 20 Vdc, f = 100 MHz) | fτ | 200 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, lg | = 0, f = 1.0 MHz) | C _{obo} | _ | 8.0 | pF |
| Input Capacitance (VBE = 2.0 Vdc, Ic | ; = 0, f = 1.0 MHz) | C _{ibo} | _ | 30 | pF |
| SWITCHING CHARA | CTERISTICS | | | <u></u> | · |
| Turn-On Time | | ton | | 45 | ns |
| Delay Time | (V _{CC} = 30 Vdc, I _C = 150 mAdc, I _{B1} = 15 mAdc) (Figures 1 and 5) | td | _ | 10 | ns |
| Rise Time | .Bl = 10 made, (righten falle of | t _r | _ | 40 | ns |
| Turn-Off Time | | toff | _ | 100 | กร |
| Storage Time | (V _{CC} = 6.0 Vdc, I _C = 150 mAdc, I _{B1} = I _{B2} = 15 mAdc) (Figure 2) | t _s | | 80 | ns |
| Fail Time | .B1 .B2 | tf | | 30 | ns |

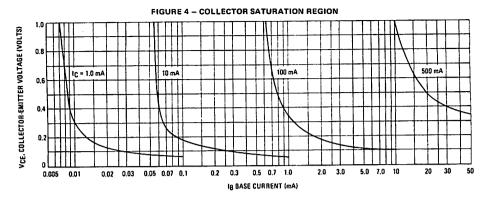
⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

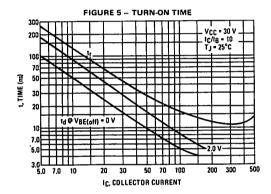


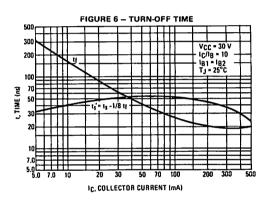
TYPICAL CHARACTERISTICS



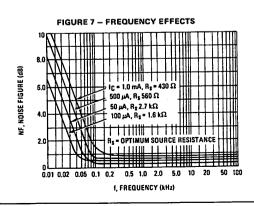
⁽²⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.

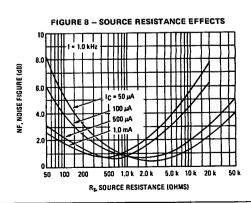




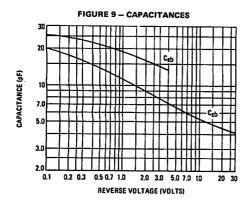


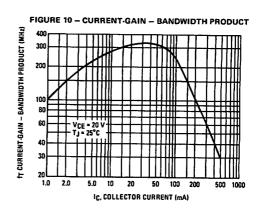
TYPICAL SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VCE = 10 Vdc, TA = 25°C

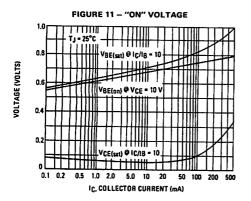


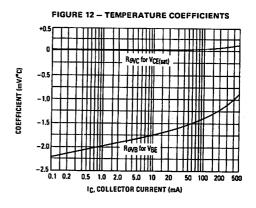


MPS2907, MPS2907A









MPS3390 thru MPS3398

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MINVINIONI UNI IIAGO | | | |
|---|-----------------------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 25 | Vdc |
| Collector-Base Voltage | VCBO | 25 | Vdc |
| Emitter-Base Voltage | VEBO | 5 | Vdc |
| Collector Current — Continuous | lc | 100 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction | T _J , T _{stg} | -55 to +150 | .€ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|-------------------|-----|------|
| Thermal Resistance, Junction to Ambient | R _Ø JA | 200 | •c/w |

Refer to 2N3903 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|---|------------------|--|---|------------|
| OFF CHARACTERISTICS | | | • | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, IB = 0) | | V(BR)CEO | 25 | _ | ٧ |
| Collector Cutoff Current (VCB = 18 Vdc, IE = 0) | | СВО | _ | 0.1 | μ Α |
| Emitter Cutoff Current (VEB = 5.0 Vdc, IC = 0) | | IEBO | | 0.1 | ДΑ |
| ON CHARACTERISTICS | | ä | | | |
| DC Current Gain (V _{CE} = 4.5 Vdc, I _C = 2.0 mAdc) | MPS3390 MPS3391 MPS3392 MPS3393 MPS3394 MPS3396 MPS3396 MPS3397 MPS3398 | hfE | 400 250 150 90 55 150 90 55 | 800 500 300 180 110 500 500 500 800 | _ |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Output Capacitance (V _{CB} = 10 V, I _E = 0, f = 1.0 MHz) | | C _{obo} | | 10 | pF |
| Small-Signal Current Gain (VCE = 4.5 V, IC = 2.0 mA, f = 1.0 kHz) | MPS3390 MPS3391 MPS3392 MPS3393 MPS3394 MPS3396 MPS3396 MPS3397 MPS3398 | h _{fe} | 400 250 150 90 55 150 90 55 | 1250 800 500 400 300 800 800 800 | _ |

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 25 | Vdc |
| Collector-Base Voltage | V _{CBO} | 25 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 100 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | ပ္ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 200 | °C/W |

MPS3391A

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

| Characteristic | Symbol | Min | Max | Unit |
|--|------------------|-----|-----------|--------------|
| OFF CHARACTERISTICS | | | | - |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, Ig = 0) | V(BR)CEO | 25 | _ | Vdc |
| Collector Cutoff Current (VCB = 25 Vdc, IE = 0) (VCB = 25 Vdc, IE = 0, TA = 100°C) | ICBO | _ | 0.1 10 | μAdc |
| Emitter Cutoff Current (VEB = 5.0 Vdc, IC = 0) | (EBO | _ | 0.1 | μAdc |
| ON CHARACTERISTICS | | - | | <u> </u> |
| DC Current Gain (IC = 2.0 mAdc, VCE = 4.5 Vdc) | hFE | 250 | 500 | - |
| SMALL-SIGNAL CHARACTERISTICS | | | ···· | ' |
| Output Capacitance {VCB = 10 Vdc, I _E = 0, f = 1.0 MHz} | C _{obo} | _ | 10 | pF |
| Current Gain — High Frequency (IC = 100 µAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{fe} | 170 | _ | |
| Noise Figure (IC = 100 µAdc, VCE = 4.5 Vdc, Rg = 5.0 kohms, f = 10 Hz to 15.7 kHz) | NF | _ | 5.0 | dB |

MPS3402 MPS3403

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|----------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 25 | Vdc |
| Collector-Base Voltage | V _{CBO} | 25 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 500 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | Tj, T _{stg} | -55 to +150 | င့ |

THERMAL CHARACTERISTICS

| *************************************** | | | |
|---|--------|------|------|
| Characteristic | Symbol | Max | Unit |
| Thermal Resistance, Junction to Case | Resc | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | RAJA | 200 | •c/w |

Refer to MPS8098 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|--------------------|----------------------|-----------|------------|----------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mA) | | V(BR)CEO | 25 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μA) | | V(BR)CBO | 25 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μA) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 18 V) (V _{CB} = 18 V, T _A = 100°C) | | ICBO | | 100 15 | nA μA |
| Emitter Cutoff Current (VBE = 5.0 V) | | lEBO | | 100 | nA |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 2.0 mA, V _{CE} = 4.5 V) (I _C = 2.0 mA, V _{CE} = 4.5 V) | MPS3402 MPS3403 | hFE | 75 180 | 225 540 | _ |
| Collector-Emitter Saturation Voltage (I _C = 50 mA, I _B = 3.0 mA) | | V _{CE(sat)} | _ | 0.3 | Vdc |
| Base-Emitter Saturation Voltage (IC = 50 mA, IB = 3.0 mA) | | V _{BE(set)} | 0.6 | 1.3 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Small-Signal Current Gain (I _C = 2.0 mA, V _{CE} = 4.5 V, f = 1.0 kHz) (I _C = 2.0 mA, V _{CE} = 4.5 V, f = 1.0 kHz) | | h _{fe} | 75 180 | = | _ |

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 50 | Vdc |
| Collector-Base Voltage | VCBO | 50 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | · lc | 500 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | ဗ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | RAIA | 200 | °C/W |

MPS3404 MPS3405

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

TRANSISTOR

NPN SILICON

Refer to MPS8098 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|---|--------------------|-----------------|--------------|------------|----------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mA) | | V(BR)CEO | 50 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μA) | | V(BR)CBO | 50 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μA) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 18 V) (V _{CB} = 18 V, T _A = 100°C) | | ІСВО | - | 100 15 | nΑ μΑ |
| Emitter Cutoff Current (VBE = 5.0 V) | | IEBO | - | 100 | nA |
| ON CHARACTERISTICS | | | | 1 | · |
| DC Current Gain (IC = 2.0 mA, V _{CE} = 4.5 V) (IC = 2.0 mA, V _{CE} = 4.5 V) | MPS3404 MPS3405 | pEE | 75 180 | 225 540 | _ |
| Collector-Emitter Saturation Voltage (I _C = 50 mA, I _B = 3.0 mA) | | VCE(sat) | _ | 0.3 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 50 mA, I _B = 3.0 mA) | | VBE(sat) | 0.6 | 1.3 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | - | | |
| Small-Signal Current Gain (IC = 2.0 mA, V _{CE} = 4.5 V, f = 1.0 kHz) (IC = 2.0 mA, V _{CE} = 4.5 V, f = 1.0 kHz) | MPS3404 MPS3405 | h _{fe} | 75 100 | = | - |

MPS3563

For Specifications, See MPS918

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MINVIMOM UNTINGS | | | |
|---|----------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 25 | Vdc |
| Collector-Base Voltage | VCBO | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | Vdc |
| Collector Current — Continuous | Ic | 200 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Power Dissipation @ T _A = 60°C | PD | 450 | mW |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | ပ္ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Case | ReJC | 83.3 | •c⁄w |
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 200 | °C/W |

Refer to 2N4400 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|-------------------|-------------|-----------|------------|
| OFF CHARACTERISTICS | | | | |
| Collector-Base Breakdown Voltage (I _C = 100 μA) | V(BR)CBO | 30 | _ | Vdc |
| Collector-Emitter Breakdown Voltage (I _C = 2.0 mA) | V(BR)CEO(sus) | 25 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µA) | V(BR)EBO | 6.0 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 25 V) (V _{CB} = 25 V, T _A = 65°C) | Ісво | | 50 3.0 | nAdc μA |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 100 µA, V _{CE} = 10 V) (I _C = 1.0 mA, V _{CE} = 10 V) | hFE | 70 150 | 600 | - |
| Collector-Emitter Saturation Voltage (I _C = 1.0 mA, I _B = 0.1 mA) | VCE(sat) | _ | 0.35 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Output Capacitance (VCB = 10 V, f = 1.0 MHz) | C _{obo} | | 4.0 | pF |
| Small-Signal Current Gain (I _C = 1.0 mA, V_{CE} = 5.0 V, f = 20 MHz) (I _C = 10 mA, V_{CE} = 5.0 V, f = 1.0 kHz) | h _{fe} , | 2.0 120 | 12 750 | _ |

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 30 | Vdc |
| Collector-Base Voltage | Vcво | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 200 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Power Dissipation @ T _A = 60°C | PD | 450 | mW |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | ReJA | 200 | °C/W |

MPS3566

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to 2N4400 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|-----------|-----------|----------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage{1} (I _C = 30 mA) | V(BR)CEO(sus) | 30 | | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μA) | V(BR)CBO | 40 | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μA) | V(BR)EBO | 5.0 | - | Vdc |
| Collector Cutoff Current (V _{CB} = 20 V) (V _{CB} = 20 V, T _A = 75°C) | ICBO | | 50 5.0 | nΑ μΑ |
| Emitter Cutoff Current (VBE = 5.0 V) | lEBO | _ | 10 | μΑ |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 10 mA, V _{CE} = 10 V) (I _C = 2.0 mA, V _{CE} = 10 V) | hFE | 150 80 | 600 | _ |
| Collector-Emitter Saturation Voltage (IC = 100 mA, Ig = 10 mA) | V _{CE(sat)} | | 1.0 | Vdc |
| Base-Emitter On Voltage(1) (IC = 100 mA, VCE = 1.0 V) | V _{BE(on)} | - | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | 1, | | · | |
| Output Capacitance (V _{CB} = 10 V, f = 1.0 MH ₂) | C _{obo} | _ | 25 | ρF |
| Small-Signal Current Gain (IC = 30 mA, VCE = 10 V, f = 20 MHz) | h _{fe} | 2.0 | 35 | _ |

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

MPS3567 MPS3568 MPS3569

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MACHINOITI INTIITOO | | | | |
|---|-----------------------------------|--------------------|---------|----------------|
| Rating | Symbol | MPS3567 MPS3569 | MPS3568 | Unit |
| Collector-Emitter Voltage | VCEO | 40 | 60 | Vdc |
| Collector-Base Voltage | VCBO | 8 | 10 | Vdc |
| Emitter-Base Voltage | VEBO | 5 | .0 | Vdc |
| Collector Current — Continuous | lc | 6 | 00 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1 - | 25 5 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1 | .5 2 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to | + 150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit | | |
|---|--------|------|------|--|--|
| Thermal Resistance, Junction to Case | RAIC | 83.3 | °¢⁄W | | |
| Thermal Resistance, Junction to Ambient | RAIA | 200 | °C/W | | |

Refer to 2N4400 for graphs for MPS3567, 3569.*

| Characteristic | | Symbol | Min | Max | Unit |
|--|---|----------------------|-----------------|-----------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Sustaining Voltage(1) (IC = 30 mAdc, IB = 0) | MPS3567, MPS3569 MPS3568 | VCEO(sus) | 40 60 | = | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0) | | V(BR)CBO | 80 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | | Vdc |
| Collector Cutoff Current $(V_{CB} = 40 \text{ Vdc}, I_E = 0)$ $(V_{CB} = 40 \text{ Vdc}, I_E = 0, T_A = 75^{\circ}\text{C})$ | | ІСВО | | 50 5.0 | nAdc μAdc |
| Emitter Cutoff Current (VEB = 4.0 Vdc, IC = 0) | | ^I EBO | | 25 | nAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain (IC = 30 mAdc, VCE = 1.0 Vdu) (IC = 150 mAdc, VCE = 1.0 Vdc) | MPS3567, MPS3568 MPS3569 MPS3567, MPS3568 | hFE | 40 100 40 | 120 | - |
| Collector-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) | MPS3569 | VCE(sat) | 100 | 0.25 | Vdc |
| Base-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) | | V _{BE(sat)} | _ | 1.1 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | - <u>-</u> | | , | |
| Current-Gain — Bandwidth Product(1) (I _C = 50 mAdc, V _{CE} = 10 Vdc, f = 20 MHz) | | fT | 60 | _ | MHz |
| Output Capacitance (VCB = 10 V, f = 1.0 MHz) | | C _{obo} | _ | 20 | pF |
| Input Capacitance (VFB = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | | C _{ibo} | - | 80 | pF |

^{*}Refer to MPS8098 for graphs for MPS3568.

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 25 | Vdc |
| Collector-Emitter Voltage | VCES | 25 | Vdc |
| Collector-Base Voltage | V _{CBO} | 25 | Vdc |
| Emitter-Base Voltage | VEBO | 40 | Vdc |
| Collector Current — Continuous | lc | 500 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | င့ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|----------------------|------|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 200 | •cw |

⁽¹⁾ Raja is measured with the device soldered into a typical printed circuit board.

MPS3638A

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

SWITCHING TRANSISTOR

PNP SILICON

Refer to 2N4402 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|---------------------|-----------------------|-----------|--------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 100 µAdc, VBE = 0) | | V(BR)CES | 25 | _ | Vdc |
| Collector-Emitter Sustaining Voltage(1) (IC = 10 mAdc, IB = 0) | | V _{CEO(sus)} | 25 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μAdc, IE = 0) | | V(BR)CBO | 25 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 4.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 15 Vdc, VBE = 0) (VCE = 15 Vdc, VBE = 0, TA = -65°C) | | ICES | _ | 0.035 2.0 | μAdc |
| (VEB = 3.0 V, IC = 0) | | IEBO | _ | 35 | nA |
| Base Current (VCE = 15 Vdc, VBE = 0) | | lΒ | _ | 0.035 | μAdc |
| ON CHARACTERISTICS(1) | | | | · | |
| DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) | MPS3638A | hFE | 80 | | _ |
| (IC = 10 mAdc, VCE = 10 Vdc) | MPS3638 MPS3638A | | 20 100 | _ | |
| (I _C = 50 mAdc, V _{CE} = 1.0 Vdc) | MPS3638 MPS3638A | | 30 100 | = | |
| (I _C = 300 mAdc, V _{CE} = 2.0 Vdc) | MPS3638 MPS3638A | | 20 20 | _ | |
| Collector-Emitter Saturation Voltage (I _C = 50 mAdc, I _B = 2.5 mAdc) (I _C = 300 mAdc, I _B = 30 mAdc) | | VCE(sat) | - | 0.25 1.0 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 50 mAdc, I _B = 2.5 mAdc) (I _C = 300 mAdc, I _B = 30 mAdc) | | V _{BE(sat)} | 0.80 | 1.1 2.0 | Vdc |

MPS3638, MPS3638A

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

| | Characteristic | | Symbol | Min | Max | Unit |
|---|---|----------------------|------------------|------------|----------|--------------------|
| SMALL-SIGNAL CHARAC | CTERISTICS | | | | | |
| Current-Gain — Bandwid (VCE = 3.0 Vdc, IC = ! | ith Product 50 mAdc, f = 100 MHz) | MPS3638 MPS3638A | fτ | 100 150 | = | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, t _E = 0 | ;), f = 1.0 MHz) | MPS3638 MPS3638A | C _{obo} | = | 20 10 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = | 0, f = 1.0 MHz) | MPS3638 MPS3638A | C _{ibo} | 1 1 | 65 25 | pF |
| Input Impedance | = 10 Vdc, f = 1.0 kHz) | | hie | 1 | 2000 | Ohms |
| Voltage Feedback Ratio (IC = 10 mAdc, VCE = | = 10 Vdc, f = 1.0 kHz) | MPS3638 MPS3638A | h _{re} | | 26 15 | X 10 ⁻⁴ |
| Small-Signal Current Gai (IC = 10 mAdc, VCE = | in = 10 Vdc, f = 1.0 kHz) | MPS3638 MPS3638A | h _{fe} | 25 100 | = | _ |
| Output Admittance | = 10 Vdc, f = 1.0 kHz) | | h _{oe} | _ | 1.2 | mmhos |
| SWITCHING CHARACTE | RISTICS | | | | | |
| Delay Time | (V _{CC} = 10 Vdc, I _C = 300 m | nAdc, | t _d | | 20 | ns |
| Rise Time | IB1 = 30 mAdc) | | t _r | _ | 70 | ns |
| Storage Time | (VCC = 10 Vdc, IC = 300 n | | t _s | | 140 | ns |
| Fail Time | lg1 = 30 mAdc, lg2 = 30 n | nAdc) | tf | | 70 | ns |
| Turn-On Time | (I _C = 300 mAdc, I _{B1} = 30 | mAdc) | ton | | 75 | ns |
| Turn-Off Time | (IC = 300 mAdc, IB1 = 30 | mAdc, IB2 = 30 mAdc) | toff | | 170 | ns |

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

| Rating | Symbol | Value | Unit |
|---|----------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 12 | Vdc |
| Collector-Base Voltage | VCBO | 12 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | lc | 80 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, Tstg | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Į | Characteristic | Symbol | Max | Unit |
|---|---|--------|------|------|
| ١ | Thermal Resistance, Junction to Case | ReJC | 83.3 | °C/W |
| ı | Thermal Resistance, Junction to Ambient | RAIA | 200 | °C/W |

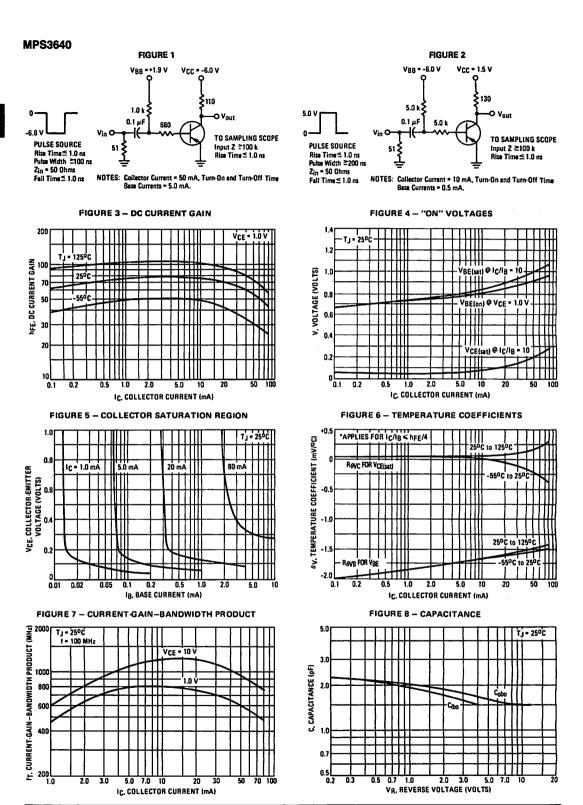
MPS3640

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

SWITCHING TRANSISTOR

PNP SILICON

| Characteristic | Symbol | Min | Max | Unit |
|---|-----------------------|-----------------|--------------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 100 μAdc, V _{BE} = 0) | V(BR)CES | 12 | <u> </u> | Vdc |
| Collector-Emitter Sustaining Voltage(1) (I _C = 10 mAdc, I _B = 0) | V _{CEO(sus)} | 12 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 12 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | V(BR)EBO | 4.0 | _ | Vdc |
| Collector Cutoff Current $(V_{CE} = 6.0 \text{ Vdc}, V_{BE} = 0)$ $(V_{CE} = 6.0 \text{ Vdc}, V_{BE} = 0, T_{A} = 65^{\circ}\text{C})$ | ICES | = | 0.01 1.0 | μAdc |
| Base Current (VCE = 6.0 Vdc, VBE = 0) | 1 _B | _ | 10 | nAdc |
| ON CHARACTERISTICS(1) | | | | |
| DC Current Gain (I _C = 10 mAdc, V _{CE} = 0.3 Vdc) (I _C = 50 mAdc, V _{CE} = 1.0 Vdc) | hFE | 30 20 | 120 — | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc) (I _C = 10 mAdc, I _B = 1.0 mAdc, T_A = 65°C) | VCE(sat) | - | 0.2 0.6 0.25 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 0.5 mAdc) (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc) | V _{BE(sat)} | 0.75 0.8 | 0.95 1.0 1.5 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 5.0 Vdc, f = 100 MHz) | fŢ | 500 | _ | MHz |
| Output Capacitance (V _{CB} = = 5.0 Vdc, I _E = 0, f = 1.0 MHz) | Cobo | - | 3.5 | ρF |
| Input Capacitance (VBE = 0.5 Vdc, IC = 0, f = 1.0 MHz) | Cibo | _ | 3.5 | pF |
| SWITCHING CHARACTERISTICS | | | | |
| Delay Time (VCC = 6.0 Vdc, IC = 50 mAdc, VBE(off) = 1.9 Vdc, | td | _ | 10 | ns |
| Rise Time IB1 = 5.0 mAdc) | tr | | 30 | ns |
| Storage Time $(V_{CC} = 6.0 \text{ Vdc}, I_{C} = 50 \text{ mAdc}, I_{B1} = I_{B2} = 5.0 \text{ mAdc})$ | ts | | 20 | ns |
| Fall Time | tf | _ | 12 | ns |
| Turn-On Time ($V_{CC} = 6.0 \text{ Vdc}$, $I_{C} = 50 \text{ mAdc}$, $V_{BE(off)} = 1.9 \text{ Vdc}$, $I_{B1} = 5.0 \text{ mAdc}$) ($V_{CC} = 1.5 \text{ Vdc}$, $I_{C} = 10 \text{ mAdc}$, $I_{B1} = 0.5 \text{ mAdc}$) | t _{on} | _ | 25 60 | ns |
| Turn-Off Time (V _{CC} = 6.0 Vdc, I _C = 50 mAdc, V _{BE(off)} = 1.9 V, I _{B1} = I _{B2} = 5.0 mAdc) (V _{CC} = 1.5 Vdc, I _C = 10 mAdc, I _{B1} = I _{B2} = 0.5 mAdc) | ^t off | = | 35 75 | ns |



MPS3644 MPS3645

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Rating Symbol | | | Unit |
|---|-----------------------|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | MPS3644 MPS3645 | VCEO | 45 60 | Vdc |
| Collector-Base Voltage | MPS3644 MPS3645 | VCBO | 45 60 | Vdc |
| Emitter-Base Voltage | | VEBO | 5.0 | Vdc |
| Total Device Dissipation @ Derate above 25°C | T _A = 25°C | PD | .625 | Watts mW/°C |
| Operating and Storage Jun Temperature Range | ection | T _J , T _{stg} | -55 to +150 | °C |

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristi | c | | Symbol | Min | Max | Unit |
|---|---|--------------------|-----------------------|-------------------------------------|------------------------|----------|
| OFF CHARACTERISTICS | | | | | • | |
| Collector-Emitter Sustaining Voltage(1) (IC = 1 | | MPS3644 MPS3645 | V _{CEO(sus)} | 45 60 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μ | | MPS3644 MPS3645 | V _{(BR)CBO} | 45 60 | = | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μA) | | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 30 Vdc) (VCE = 50 Vdc) (VCE = 30 Vdc, @ TA = 65°C) (VCE = 50 Vdc, @ TA = 65°C) | MPS3644 MPS3645 MPS3644 MPS3645 | | ICES | | 35 35 2.0 2.0 | nA μA |
| ON CHARACTERISTICS | | | | | · | |
| DC Current Gain (I _C = 100 μ A, V _{CE} = 10 Vdc) (I _C = 1.0 mA, V _{CE} = 10 Vdc) (I _C = 10 mA, V _{CE} = 10 Vdc) (I _C = 50 mA, V _{CE} = 1.0 Vdc) (I _C = 150 mA, V _{CE} = 10 Vdc) (I _C = 300 mA, V _{CE} = 2.0 Vdc) (I _C = 300 mA, V _{CE} = 2.0 Vdc) | 1) (1) | | ptE | 40 80 100 115 100 20 | 300 300 300 | _ |
| | nA, lg = 2.5 mA)(1) mA, lg = 15 mA)(1) mA, lg = 30 mA)(1) | | V _{CE(sat)} | = ., | 0.25 0.4 1.0 | Vdc |
| (IC = 300 mA, | B = 2.5 mA)(1) IB = 15 mA)(1) IB = 30 mA)(1) | | V _{BE(sat)} | | 1.0 1.3 2.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | , |
| Output Capacitance (VCB = 10 Vdc) | | | C _{obo} | | 8.0 | pF |
| Input Capacitance (VEB = 0.5 Vdc) | | | C _{ibo} | | 25 | pF |
| Input Impedance (IC = 10 mA, VCE = 10 Vdc, i | | | h _{ie} | | 2000 | U |
| Voltage Feedback Ratio (IC = 10 mA, VCE = 10 | | | h _{re} | | 1500 | -6X10 |
| Small-Signal Current Gain (IC = 20 mA, VCE = $(IC = 10 \text{ mA}, VCE = 10 \text{ mA})$ | | | h _{fe} | 2.0 100 | _ | _ |
| Output Admittance (IC = 10 mA, VCE = 10 Vdc | c, f = 1.0 kHz) | | hoe | | 1200 | μmhos |
| SWITCHING CHARACTERISTICS (FIGURE 1) | · | | | | | |
| Turn-On Time (IC = 300 mA, IB1 = 30 mA) | | | ton | | 40 | ns |
| Turn-Off Time ($I_C = 300 \text{ mA}$, $I_{B1} = I_{B2} = 30 \text{ m}$ | nA) | | t _{off} | - | 100 | ns |

(1) Pulse Width = 300 µsec., Duty Cycle = 1.0%.

MPS3646

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MAXIMUM HATINGS | | | |
|---|------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 15 | Vdc |
| Collector-Emitter Voltage | VCES | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous — 10 μs Pulse | lc | 300 500 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12.0 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, Tstg | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------|------|
| Thermal Resistance, Junction to Case | RAJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | Raja | 200 | °C/W |

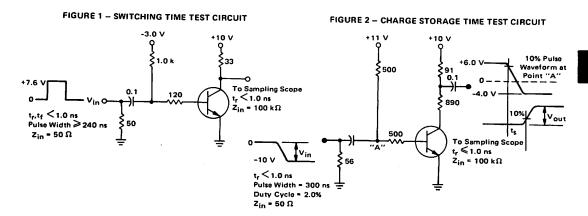
Refer to 2N4264 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|--|-----------------------|----------------|---------------------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 100 μAdc, V _{BE} = 0) | V(BR)CES | 40 | | Vdc |
| Collector-Emitter Sustaining Voltage(1) (IC = 10 mAdc, IB = 0) | V _{CEO(sus)} | 15 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0) | V(BR)CBO | 40 | | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 µAdc, IC = 0) | V(BR)EBO | 5.0 | | Vdc |
| Collector Cutoff Current (V _{CE} = 20 Vdc, V _{BE} = 0) (V _{CE} = 20 Vdc, V _{BE} = 0, T _A = 65°C) | ICES | - | 0.5 3.0 | μAdc |
| ON CHARACTERISTICS(1) | | | | |
| DC Current Gain (IC = 30 mAdc, V_{CE} = 0.4 Vdc) (IC = 100 mAdc, V_{CE} = 0.5 Vdc) (IC = 300 mA, V_{CE} = 1.0 Vdc) | hFE | 30 25 15 | 120 — — | _ |
| Collector-Emitter Saturation Voltage (I _C = 30 mAdc, I _B = 3.0 mAdc) (I _C = 100 mAdc, I _B = 10 mAdc) (I _C = 300 mAdc, I _B = 30 mAdc) (I _C = 300 mAdc, I _B = 3.0 mA, T _A = 65°C) | VCE(sat) | 1111 | 0.2 0.28 0.5 0.3 | Vdc |
| Base-Emitter Saturation Voltage ($I_C = 30 \text{ mAdc}$, $I_B = 3.0 \text{ mAdc}$) ($I_C = 100 \text{ mAdc}$, $I_B = 10 \text{ mAdc}$) ($I_C = 300 \text{ mAdc}$, $I_B = 30 \text{ mA}$) | VBE(sat) | 0.73 — — | 0.95 1.2 1.7 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 30 mAdc, VCE = 10 Vdc, f = 100 MHz) | fŢ | 350 | | MHz |
| Output Capacitance (VCB = 5.0 Vdc, IE = 0, f = 1.0 MHz) | C _{obo} | - | 5.0 | pF |
| Input Capacitance (V _{BE} = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | C _{ibo} | 1 | _ | pF |
| SWITCHING CHARACTERISTICS | | | | |
| Turn-On Time | ton | | 18 | ns |
| VCC = 10 Vdc, VBE(off) = 3.0 Vdc, IC = 300 mAdc, IB1 = 30 mAdc) (Figure 1) | t _d | | 10 | ns |
| Rise Time | t _r | | 15 | ns |
| Turn-Off Time (V _{CC} = 10 Vdc, l _C = 300 mAdc, l _{B1} = l _{B2} = 30 mAdc | toff | | 28 | ns |
| Fall Time (Figure 1) | tf | | 15 | ns |
| Storage Time (V _{CC} = 10 Vdc, I _C = 10 mAdc, I _{B1} = I _{B2} = 10 mAdc) (Figure 2) | ts | _ | 18 | ns |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MPS3646



MPS3702 MPS3703

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | MPS3702 | MPS3703 | Unit |
|---|----------------------|---------|----------|-------------|
| Collector-Emitter Voltage | VCEO | 25 | 30 | Vdc |
| Collector-Base Voltage | V _{CBO} | 40 | 50 | Vdc |
| Emitter-Base Voltage | VEBO | 5 | .0 | Vdc |
| Collector Current — Continuous | lc | 6 | 00 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1 - | 25 .0 | mW mW/°C |
| Operating and Storage Junction Temperature Range | Tj, T _{stg} | - 55 to | + 150 | °C |

THERMAL CHARACTERISTICS

| THE HISTORY | | | |
|---|------------------|-----|------|
| Characteristic | Symbol | Max | Unit |
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 0.2 | °C/W |

Refer to 2N4402 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|--------------------|---------------------|----------|------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | MPS3702 MPS3703 | V(BR)CEO | 25 30 | <u>-</u> | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | MPS3702 MPS3703 | V(BR)CBO | 40 50 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 20 Vdc, !E = 0) | | ICBO | | 100 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | | IEBO | - | 100 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(1) (I _C = 50 mAdc, V _{CE} = 5.0 Vdc) | MPS3702 MPS3703 | hFE | 60 30 | 300 150 | _ |
| Collector-Emitter Saturation Voltage(1) (I _C = 50 mAdc, I _B = 5.0 mAdc) | | VCE(sat) | | 0.25 | Vdc |
| Base-Emitter On Voltage(1) (IC = 50 mAdc, VCE = 5.0 Vdc) | | V _{BE(on)} | 0.6 | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (I _C = 50 mAdc, V _{CE} = 5.0 Vdc, f = 20 MHz) | | fT | 100 | | MHz |
| Output Capacitance (VCR = 10 Vdc, f = 1.0 MHz) | | C _{obo} | | 12 | pF |

⁽¹⁾ Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

| Rating | Symbol | MPS3704 MPS3705 | MPS3706 | Unit |
|---|-----------------------------------|--------------------|---------|-------------|
| Collector-Emitter Voltage | VCEO | 30 | 20 | Vdc |
| Collector-Base Voltage | VCBO | 50 | 40 | Vdc |
| Emitter-Base Voltage | VEBO | | , | Vdc |
| Collector Current — Continuous | ıc | 600 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | | °C |

THERMAL CHARACTERISTICS

| *************************************** | | | |
|---|--------|-----|------|
| Characteristic | Symbol | Max | Unit |
| Thermal Resistance, Junction to Ambient | RAIA | 0.2 | °C/W |

MPS3704 thru MPS3706

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N4400 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|---|-------------------------------|---------------------|-----------------|-------------------|----------|
| OFF CHARACTERISTICS | | | | <u> </u> | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IE = 0) | MPS3704 MPS3705 MPS3706 | V(BR)CEO | 30 30 20 | = = | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | MPS3704 MPS3705 MPS3706 | V(BR)CBO | 50 50 40 | = | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 μ Adc, IC = 0) | | V(BR)EBO | 5.0 | - | Vdc |
| Collector Cutoff Current (VCB = 20 Vdc, I _E = 0) | | ІСВО | _ | 100 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, I _C = 0) | | lEBO | - | 100 | nAdc |
| ON CHARACTERISTICS | | | | Ш | <u> </u> |
| DC Current Gain(1) (IC = 50 mAdc, V _{CE} = 2.0 Vdc) | MPS3704 MPS3705 MPS3706 | pŁE | 100 50 30 | 300 150 600 | _ |
| Collector-Emitter Saturation Voltage(1) (IC = 100 mAdc, tg = 5.0 mAdc) | MPS3704 MPS3705 MPS3706 | VCE(sat) | | 0.6 0.8 1.0 | Vdc |
| Base-Emitter On Voltage(1) (IC = 100 mAdc, VCE = 2.0 Vdc) | | V _{BE(on)} | 0.5 | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | <u></u> | | | | |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 2.0 Vdc, f = 20 MHz) | | fT | 100 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | | C _{obo} | _ | 12 | pF |

(1) Pulse Test: Pulse Width = 300 μ s, Duty Cycle = 2.0%.

MPS3707 MPS3710 MPS3711

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|-----------------------------------|-------------|---------------|
| Collector-Emitter Voltage | VCEO | 30 | Vdc |
| Collector-Base Voltage | VCBO | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | Vdc |
| Collector Current | lc | 30 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | င့ |

THERMAL CHARACTERISTICS

| TILIMAL OFFICE TO THE TOTAL | | | |
|---|--------|------|------|
| Characteristic | Symbol | Max | Unit |
| Thermal Resistance, Junction to Ambient | RAJA | 200 | °C/W |
| Thermal Resistance, Junction to Case | Rajc | 83.3 | •c/w |

Refer to MPS3903 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|-------------------------------|-----------------|------------------|-------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) | | V(BR)CEO | 30 | - | _ v |
| Collector Cutoff Current (VCB = 20 Vdc, IE = 0) | | СВО | | 100 | nA |
| Emitter Cutoff Current (VBE = 6.0 Vdc, IC = 0) | | IEBO | | 100 | nA |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 100 µAdc, V _{CE} = 5.0 Vdc) (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc) | MPS3707 MPS3710 MPS3711 | hFE | 100 90 180 | 400 330 660 | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 0.5 mAdc) | | VCE(sat) | | 1.0 | V |
| Base-Emitter On Voltage (IC = 1.0 mAdc, VCE = 5.0 Vdc) | | VBE(on) | 0.5 | 1.0 | v |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Small-Signal Current Gain (IC = 100 μ Adc, VCE = 5.0 Vdc, f = 1.0 KHz) (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 KHz) | MPS3707 MPS3710 MPS3711 | h _{fe} | 100 90 180 | 550 450 800 | _ |
| Noise Figure(1) (VCE = 5.0 V, I _C = 100 μ A) (RG = 5.0 K Ω , Noise Bandwidth = 15.7 KHz) | MPS3707 | NF | _ | 5.0 | dB |

⁽¹⁾ Average Noise Figure is measured in an amplifier with low frequency response down 3 dB at 10 c/s.

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 30 | Vdc |
| Collector-Base Voltage | V _{CBO} | 55 | Vdc |
| Emitter-Base Voltage | VEBO | 3.5 | Vdc |
| Collector Current — Continuous | lc | 0.4 | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------|------|
| Thermal Resistance, Junction to Case | ReJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | RAJA | 200 | °C/W |

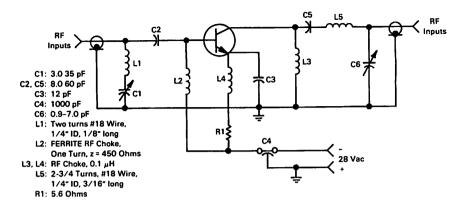
MPS3866

CASE 29-02, STYLE 1 TO-92 (TO-226AA) AMPLIFIER TRANSISTOR

NPN SILICON

| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|-----------|------------|-------------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 5.0 mAdc, R _{BE} = 10 Ω) | VCER(sus) | 55 | _ | Vdc |
| Collector-Emitter Sustaining Voltage (I _C = 5.0 mAdc, I _B = 0) | VCEO(sus) | 30 | | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 µAdc, IC = 0) | V(BR)EBO | 55 | | Vdc |
| Collector Cutoff Current (VCE = 28 Vdc, I _B = 0) | ICEO | 3.5 | 0.02 | mAdc |
| Collector Cutoff Current (VCE = 30 Vdc, VBE = -1.5 Vdc (Rev.), TC = 150°C) (VCE = 55 Vdc, VBE = -1.5 Vdc (Rev.) | ICEX | = | 5.0 0.1 | mAdc |
| Emitter Cutoff Current (VBE = 3.5 Vdc, I _C = 0) | IEBO | _ | 0.1 | mAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 360 mAdc, V _{CE} = 5.0 Vdc)(1) (I _C = 50 mAdc, V _{CE} = 5.0 Vdc) | hFE | 5.0 10 | 200 | _ |
| Collector-Emitter Saturation Voltage (IC = 100 mAdc, IB = 20 mAdc) | VCE(sat) | _ | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 15 Vdc, f = 200 MHz) | fτ | 500 | _ | MHz |
| Output Capacitance (VCB = 28 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | _ | 3.0 | ρF |
| FUNCTIONAL TEST | <u>_</u> | | · | |
| Amplifier Power Gain (VCC = 28 Vdc, P _{out} = 1.0 W, f = 400 MHz) | G _{pe} | 10 | _ | dB |
| Collector Efficiency (V _{CC} = 28 Vdc, P _{out} = 1.0 W, f = 400 MHz) | η | 45 | | % |

FIGURE 1 - 400 MHz TEST CIRCUIT SCHEMATIC



| Rating | Symbol | Value | Unit |
|---|----------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | VCBO | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | Vdc |
| Collector Current — Continuous | Ic | 200 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Power Dissipation @ T _A = 60°C | PD | 450 | mW |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | °C |

Temperature Hange

| THERMAL CHARACTERISTICS | | | |
|---|-----------------|------|------|
| Characteristic | Symbol | Max | Unit |
| Thermal Resistance, Junction to Case | R _{NC} | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | ROJA | 200 | °C/W |

MPS3903 MPS3904

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

| Characteristic | | Symbol | Min | Max | Unit |
|--|---------------------------------------|----------------------|-----------|-------------|---------------------------------------|
| OFF CHARACTERISTICS | | | | • | · · · · · · · · · · · · · · · · · · · |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | | V(BR)CEO | 40 | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | | V(BR)CBO | 60 | _ | Vdc |
| Emitter-Base Breakdown Voltage $(I_E = 10 \mu Adc, I_C = 0)$ | | V(BR)EBO | 6.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 30 Vdc, VEB(off) = 3.0 Vdc) | | ICEX | | 50 | nAdc |
| Base Cutoff Current (VCE = 30 Vdc, VEB(off) = 3.0 Vdc) | | IBL | _ | 50 | nAdc |
| ON CHARACTERISTICS(1) | · · · · · · · · · · · · · · · · · · · | | | | |
| DC Current Gain (I _C = 0.1 mAdc, V _{CE} = 1.0 Vdc) | MPS3903 MPS3904 | hFE | 20 40 | = | _ |
| (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) | MPS3903 MPS3904 | | 35 70 | = | |
| (IC = 10 mAdc, V_{CE} = 1.0 Vdc) | MPS3903 MPS3904 | - | 50 100 | 150 300 | |
| (I _C = 50 mAdc, V_{CE} = 1.0 Vdc) | MPS3903 MPS3904 | | 30 60 | = | |
| I _C = 100 mAdc, V _{CE} = 1.0 Vdc) | MPS3903 MPS3904 | | 15 30 | = | |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc) | | V _{CE(sat)} | _ | 0.2 0.3 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc) | | V _{BE(sat)} | 0.65 | 0.85 1.0 | Vdc |

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| | Characteristic | | Symbol | Min | Max | Unit |
|--|---|--------------------|------------------|------------|------------|--------|
| SMALL-SIGNAL CHAI | RACTERISTICS | * | | | | |
| Current-Gain — Bando (IC = 10 mAdc, VCE | width Product = = 20 Vdc, f = 100 MHz) | MPS3903 MPS3904 | fτ | 150 200 | | MHz |
| Output Capacitance (VCB = 5.0 Vdc, IE | = 0, f = 100 kHz) | | C _{obo} | _ | 4.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC | | | C _{ibo} | _ | 8.0 | pF |
| Input Impedance (IC = 1.0 mAdc, Vo | ce = 10 Vdc, f = 1.0 kHz) | MPS3903 MPS3904 | h _{ie} | 0.5 1.0 | 8.0 10 | kΩ |
| Voltage Feedback Rat (IC = 1.0 mAdc, Vo | tio CE = 10 Vdc, f = 1.0 kHz) | MPS3903 MPS3904 | h _{re} | 0.1 0.5 | 5.0 8.0 | X 10-4 |
| Small-Signal Current (IC = 1.0 mAdc, VC | Gain CE = 10 Vdc, f = 1.0 kHz) | MPS3903 MPS3904 | h _{fe} | 50 100 | 200 400 | _ |
| Output Admittance | CE = 10 Vdc, f = 1.0 kHz) | | h _{oe} | 1.0 | 40 | μmhos |
| Noise Figure | CE = 5.0 Vdc, RS = 1.0 kΩ, | MPS3903 MPS3904 | NF | <u>-</u> | 6.0 5.0 | dB |
| SWITCHING CHARAC | CTERISTICS | | | | | • |
| Delay Time | (VCC = 3.0 Vdc, VBE(off) = 0.5 Vdc | С, | td | _ | 35 | ns |
| Rise Time | IC = 10 mAdc, IB1 = 1.0 mAdc) | | t _r | | 50 | ns |
| Storage Time | (VCC = 3.0 Vdc, IC = 10 mAdc, | MPS3903 MPS3904 | t _S | _ | 800 900 | ns |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

Fall Time

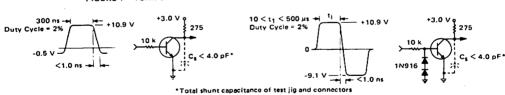
EQUIVALENT SWITCHING TIME TEST CIRCUITS

FIGURE 1 - TURN-ON TIME

IB1 = IB2 = 1.0 mAdc)

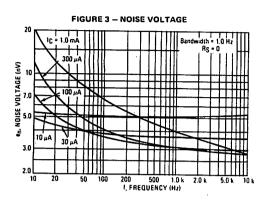
FIGURE 2 - TURN-OFF TIME

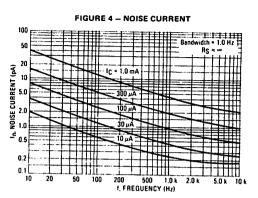
۱f



ns

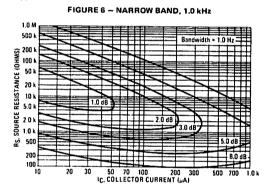
TYPICAL NOISE CHARACTERISTICS (VCE = 5.0 Vdc, TA = 25°C)

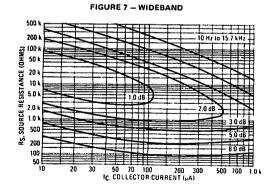




NOISE FIGURE CONTOURS (VCE = 5.0 Vdc, TA = 25°C)

FIGURE 5 - NARROW BAND, 100 Hz 500 k 200 (SE 50 k SOURCE RESISTANCE 201 10 (5.0 (2.0 k 1.0 k 500 200 100 50 200 380 IC. COLLECTOR CURRENT (PA)





Noise Figure is Defined as:

NF =
$$20 \log_{10} \left(\frac{e_n^2 + 4KTR_S + I_n^2 R_S^2}{4KTR_S} \right)^{1/2}$$

en = Noise Voltage of the Transistor referred to the input. (Figure 3)

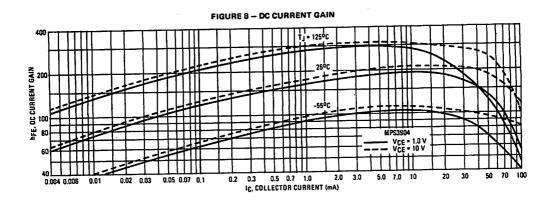
In = Noise Current of the transistor referred to the input (Figure 4)

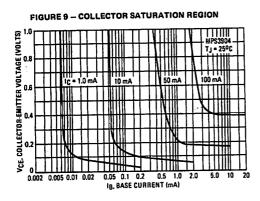
K = Boltzman's Constant (1.38 x 10-23 j/OK)

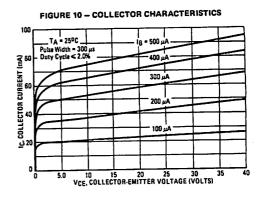
T = Temperature of the Source Resistance (OK)

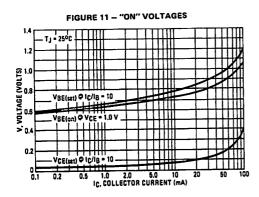
Rs = Source Resistance (Ohms)

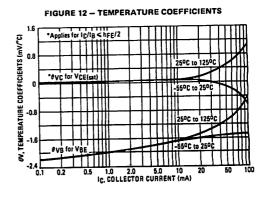
TYPICAL STATIC CHARACTERISTICS



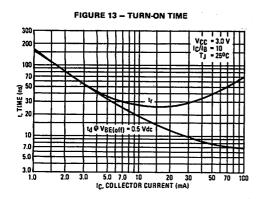


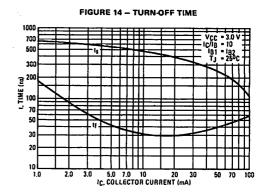


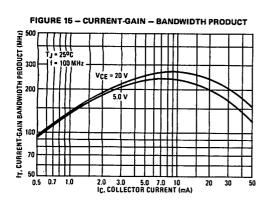


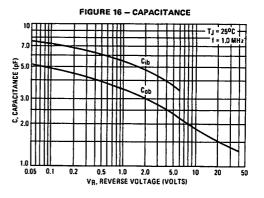


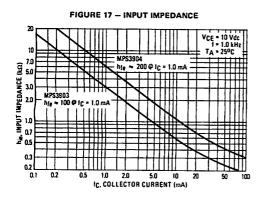
TYPICAL DYNAMIC CHARACTERISTICS

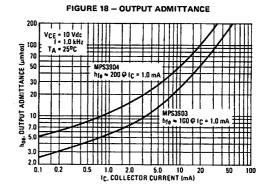


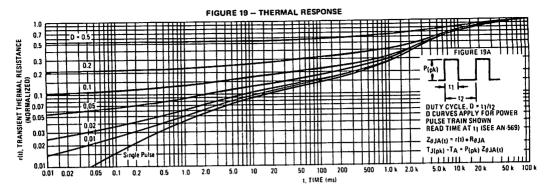












DESIGN NOTE: USE OF THERMAL RESPONSE DATA

A train of periodical power pulses can be represented by the model as shown in Figure 19A. Using the model and the device thermal response the normalized effective transient thermal resistance of Figure 19 was calculated for various duty cycles.

To find $Z_{0JA(t)}$, multiply the value obtained from Figure 19 by the steady state value R_{0JA} .

Example:

The MPS3903 is dissipating 2.0 watts peak under the following conditions:

 $t_1 = 1.0 \text{ ms}, t_2 = 5.0 \text{ ms}. (D = 0.2)$

Using Figure 19 at a pulse width of 1.0 ms and D = 0.2, the reading of r(t) is 0.22.

The peak rise in junction temperature is therefore $\Delta T = r(t) \times P(pk) \times R_0 JA = 0.22 \times 2.0 \times 200 = 88^{\circ}C.$

For more information, see AN-569.

The safe operating area curves indicate IC-VCE limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 20 is based upon $T_{J(pk)} = 150^{\circ}C$; T_{C} or T_{A} is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \le 150^{\circ}C$. $T_{J(pk)}$ may be calculated from the data in Figure 19. At high case or ambient temperatures, thermal limitations will reduce the power than can be handled to values less than the limitations imposed by second breakdown. (See AN-415A).

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | VCBO | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Base Current | lв | 200 | Vdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Power Dissipation @ T _A = 60°C | PD | 450 | mW |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | ReJA | 200 | °C/W |

MPS3905 MPS3906

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

Refer to 2N5088 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------|----------------------|------------|--------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | | V(BR)CEO | 40 | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 μAdc, IE = 0) | | V(BR)CBO | 40 | - | Vdc |
| Emitter-Base Breakdown Voltage ($l_E = 10 \mu Adc$, $l_C = 0$) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 30 Vdc, VBE(off) = 3.0 Vdc) | | ICEX | _ | 50 | nAdc |
| Base Cutoff Current (VCE = 30 Vdc, VBE(off) = 3.0 Vdc | | IBL | _ | 50 | nAdc |
| ON CHARACTERISTICS(1) | | | | · | |
| DC Current Gain (IC = 0.1 mAdc, VCE = 1.0 Vdc) | MPS3905 MPS3906 | hFE | 30 60 | = | _ |
| (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) | MPS3905 MPS3906 | | 40 80 | = | |
| (IC = 10 mAdc, V_{CE} = 1.0 Vdc) | MPS3905 MPS3906 | | 50 100 | 150 300 | |
| $(I_C = 50 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc})$ | MPS3905 MPS3906 | | 30 60 | = | |
| (IC = 100 mAdc, VCE = 1.0 Vdc) | MPS3905 MPS3906 | | 15 30 | _ = | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc) | | VCE(sat) | = | 0.25 0.4 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc) | | V _{BE(sat)} | 0.65 | 0.85 0.95 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz) | MPS3905 MPS3906 | fΤ | 200 250 | _ | MHz |

Storage Time

Fall Time

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

 $(V_{CC} = 3.0 \text{ Vdc}, I_{C} = 10 \text{ mAdc}, I_{B1} = I_{B2} = 1.0 \text{ mAdc})$

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------|------------------|------------|------------|--------|
| Output Capacitance (VCB = 5.0 Vdc, IE = 0, f = 100 kHz) | | Cobo | 1 | 4.5 | pF |
| Input Capacitance (VBF = 0.5 Vdc, IC = 0, f = 100 kHz) | | C _{ibo} | _ | 10 | pF |
| Input Impedance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | MPS3905 MPS3906 | h _{ie} | 0.5 2.0 | 8.0 12 | k ohms |
| Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | MPS3905 MPS3906 | h _{re} | 0.1 1.0 | 5.0 10 | X 10-4 |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | MPS3905 MPS3906 | h _{fe} | 50 100 | 200 400 | - |
| Output Admittance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | MPS3905 MPS3906 | h _{oe} | 1.0 3.0 | 40 60 | μmhos |
| Noise Figure (I _C = 100 µAdc, V _{CE} = 5.0 Vdc, R _S = 1.0 k ohm, f = 10 Hz to 15.7 kHz) | MPS3905 MPS3906 | NF | | 5.0 4.0 | dB |
| SWITCHING CHARACTERISTICS | | | | | |
| Delay Time (VCC = 3.0 Vdc, VBE(off) = 0 | .5 Vdc | t _d | _ | 35 | ns |
| Rise Time (IC = 10 mAdc, IB1 = 1.0 mA | Adc) | tr | | 50 | ns |

MPS3905

MPS3906 MPS3905

MPS3906

ts

tf

500

600

90

90

กร

(1) Pulse Test: Pulse Width = 300 \(\mu \text{s}\), Duty Cycle = 2.0%.

| MAXIMUM RATINGS | | | | |
|---|----------|--------------------|---------------------|-------|
| Rating | Symbol | MPS4248 MPS4250 | MPS4249 MPS4250A | Unit |
| Collector-Emitter Voltage | VCEO | 40 | 60 | Vdc |
| Collector-Emitter Voltage | VCES | 40 | 60 | Vdc |
| Collector-Base Voltage | VCBO | 40 | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | 5.0 | Vdc |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 0.2 | 0.2 | Watts |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 0.5 | 0.5 | Watts |
| Total Device Dissipation @ T _C = 100°C Derate above 100°C | PD | | | |
| Operating and Storage Junction Temperature Range | TJ, Tstg | -55 to +125 | | °C |
| Junction Temperature | ΤJ | 125 | | °C |
| Lead Temperature (10 seconds) | TL | 260 | | °C |

MPS4248 MPS4249 MPS4250 MPS4250A

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

TRANSISTOR

PNP SILICON

| Characteristic | | Symbol | Min | Max | Unit |
|--|---|------------------|--|-------------------------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 10 μ A) (IC = 10 μ A) (IC = 5.0 mA) (IC = 5.0 mA) | MPS4248 MPS4249 MPS4250 MPS4250A | V(BR)CES | 40 60 40 60 | = = | Vdc |
| Collector-Emitter Sustaining Voltage(1) (IC = 5.0) (IC = 5.0) | MPS4248, MPS4250 MPS4249, MPS4250A | V(BR)CEO(sus) | 40 60 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 \(\mu A \)) (IC = 10 \(\mu A \)) | MPS4248, MPS4250 MPS4249, MPS4250A | V(BR)CBO | 40 60 | = | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μA) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 40 V) (VCB = 50 V) (VCB = 40 V, TA = 65°C) | MPS4248, MPS4249, MPS4250A MPS4250 MPS4248,49,50 | ІСВО | = | 10 10 3.0 | nA |
| Emitter Cutoff Current (VBE = 3.0 V) | | EBO | _ | 20 | nA |
| ON CHARACTERISTICS DC Current Gain { C = 100 \(\mu \text{A} \), \(\text{VCE} = 5.0 \text{ V} \) { C = 100 \(\mu \text{A} \), \(\text{VCE} = 5.0 \text{ V} \) { C = 100 \(\mu \text{A} \), \(\text{VCE} = 5.0 \text{ V} \) { C = 1.0 \(\mu \text{A} \), \(\text{VCE} = 5.0 \text{ V} \) { C = 1.0 \(\mu \text{A} \), \(\text{VCE} = 5.0 \text{ V} \) { C = 1.0 \(\mu \text{A} \), \(\text{VCE} = 5.0 \text{ V} \) { C = 10 \(\mu \text{A} \), \(\text{VCE} = 5.0 \text{ V} \) { C = 10 \(\mu \text{A} \), \(\text{VCE} = 5.0 \text{ V} \) { C = 10 \(\mu \text{A} \), \(\text{VCE} = 5.0 \text{ V} \) { C = 10 \(\mu \text{A} \), \(\text{VCE} = 5.0 \text{ V} \) { C = 10 \(\mu \text{A} \), \(\text{VCE} = 5.0 \text{ V} \) | MPS4248 MPS4249 MPS4250,A MPS4248 MPS4249 MPS4250 MPS4248 MPS4248 MPS4249 | hFE | 50 100 250 50 100 250 50 100 250 | 300 700 — — — — — | _ |
| Collector-Emitter Saturation Voltage(1) (IC = 10 mA, IB = 0.5 mA) | | VCE(sat) | - | 0.25 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 10 mA, IB = 0.5 mA) SMALL-SIGNAL CHARACTERISTICS | | VBE(sat) | _ | 0.9 | Vdc |
| Output Capacitance (VCB = 5.0 V, f = 1.0 MHz) | | C _{obo} | | 6.0 | pF |

MPS4248, MPS4249, MPS4250, MPS4250A

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteri | stic | Symbol | Min | Max | Unit |
|---|--|------------------|-------------------------|-------------------------|------|
| Input Capacitance (VBE = 0.5 V, f = 1.0 MHz) | | C _{ibo} | | 16 | pF |
| Small-Signal Current Gain (IC = 1.0 mA, VCE = 5.0 V, f = 1.0 kHz) (IC = 1.0 mA, VCE = 5.0 V, f = 1.0 kHz) (IC = 1.0 mA, VCE = 5.0 V, f = 1.0 kHz) (IC = 0.5 mA, VCE = 5.0 V, f = 20 MHz) | MPS4248 MPS4249 MPS4250,A MPS4248,49,50 | h _{fe} | 50 100 250 2.0 | 1000 500 800 — | - |
| Noise Figure | | NF | | | dB |
| $(I_C = 20 \mu A, V_{CE} = 5.0 \text{ V}, R_S = 10 \text{ K}\Omega,$ $f = 1.0 \text{ kHz}, P_{BW} = 150 \text{ Hz})$ $(I_C = 20 \mu A, V_{CE} = 5.0 \text{ V}, R_S = 10 \text{ K}\Omega,$ | MPS4248,50,A | | _ | 2.0 | |
| f = 1.0 kHz, Ppw = 150 Hz) | MPS4249 | | _ | 3.0 | |
| (I _C = 250 μA, V _{CE} = 5.0 V, R _S = 1.0 KΩ, f = 1.0 kHz, P _{BW} = 150 Hz) | MPS4248,50,A | | - | 2.0 | |
| (IC = 250 μ A, VCE = 5.0 V, RS = 1.0 K Ω , f = 1.0 kHz, PRW = 150 Hz) | MPS4249 | | - | 3.0 | |

(1) Pulse Test: Pulse Width = 300 μ s, Duty Cycle = 2.0%.

| Rating | Symbol | MPS4257 | MPS4258 | Unit |
|---|-----------------------------------|-------------|---------|----------------|
| Collector-Emitter Voltage | VCEO | 6.0 | 12 | Vdc |
| Collector-Base Voltage | V _{CBO} | 6.0 | 12 | Vdc |
| Emitter-Base Voltage | VEBO | 4.5 | | Vdc |
| Collector Current — Continuous | lc | 80 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 12 | | mW mW°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------|------|
| Thermal Resistance, Junction to Case | RAJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | Rain | 200 | °CW |

MPS4257 MPS4258

CASE 29-02, STYLE 1 TO-92 (TO-226AA) SWITCHING TRANSISTORS

PNP SILICON

Refer to MPS3640 for graphs.

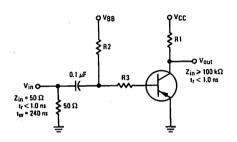
| Characteristic | | Symbol | Min | Max | Unit |
|--|--|-----------------------|----------------|----------------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (I _C = 100 μAdc, V _{BE} = 0) | MPS4257 MPS4258 | V(BR)CES | 6.0 12 | = | Vdc |
| Collector-Emitter Sustaining Voltage(1) (IC = 3.0 mAdc, IB = 0) | MPS4257 MPS4258 | V _{CEO(sus)} | 6.0 12 | = | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0) | MPS4257 MPS4258 | V(BR)CBO | 6.0 12 | = | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 4.5 | | Vdc |
| Collector Cutoff Current (VCE = 3.0 Vdc, VBE = 0) (VCE = 3.0 Vdc, VBE = 0, TA = +65°C) (VCE = 6.0 Vdc, VBE = 0) (VCE = 6.0 Vdc, VBE = 0, TA = +65°C) ON CHARACTERISTICS(1) | MPS4257 MPS4257 MPS4258 MPS4258 | ICES | = | 0.01 5.0 0.01 5.0 | μAdc |
| DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 0.5 Vdc) (I _C = 10 mAdc, V _{CE} = 3.0 Vdc) (I _C = 50 mAdc, V _{CE} = 1.0 Vdc) | | pkE | 15 30 30 | 120 | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) (IC = 50 mAdc, Ig = 5.0 mAdc) | | VCE(sat) | | 0.15 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) (IC = 50 mAdc, Ig = 5.0 mAdc) | | V _{BE(sat)} | 0.75 | 0.95 1.5 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product(2) (IC = 10 mAdc, VCE = 5.0 Vdc, f = 100 MHz) (IC = 10 mAdc, VCE = 10 Vdc, f = 100 MHz) | MPS4257 MPS4258 | fT | 500 700 | _ | MHz |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | | Cibo | _ | 3.5 | pF |
| Collector-Base Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz) | | C _{cb} | - | 3.0 | pF |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| | Characteristic | | Symbol | Min | Max | Unit |
|-----------------------------------|--|--------------------|--------|-----|----------|------|
| SWITCHING CHARA | CTERISTICS | | | | | |
| Turn-On Time | (V _{CC} = 1.5 Vdc, | | ton | | 15 | ns |
| Delay Time | VBE(off) = 0, | | | _ | 10 | ns |
| Rise Time | IC = 10 mAde, IB1 = 1.0 mAde) | | | _ | 15 | ns |
| Turn-Off Time | (VCC = 1.5 Vdc, | MPS4257 MPS4258 | toff | _ | 15 20 | ns |
| Storage Time | IC = 10 mAdc, IB1 = IB2 = 1.0 mAdc) | MPS4257 MPS4258 | ts | = | 15 20 | ns |
| Fall Time | | | tf | | 10 | ns |
| Storage Time (IC ~ 10 mAdc, IB | 1 ~ 10 mAdc, IB2 ~ 10 mAdc) | MPS4257 MPS4258 | ts | = | 15 20 | ns |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

FIGURE 1 — SWITCHING TIME TEST CIRCUIT



| | V _{in} Volts | VBB Voits | V _C C Volts | R1 Ohms | R2 Ohms | R3 Ohms | mA | IB1 mA | IB2 mA |
|------|--------------------------|--------------|---------------------------|------------|------------|------------|----|-----------|-----------|
| ton | -5.8 | GND | -1.5 | 130 | 2.2 k | 5 k | 10 | 1.0 | 1 |
| toff | +9.8 | -8.0 | -1.5 | 130 | 2.2 k | 5 k | 10 | 1.0 | 1.0 |
| ls. | +9.0 | -10 | - 3.0 | 270 | 510 | 390 | 10 | 10 | 10 |

⁽²⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.

| Rating | Symbol | MPS4274 | MPS4275 | Unit |
|---|----------------------|-------------|---------|----------------|
| Collector-Emitter Voltage | VCEO | 12 | 15 | Vdc |
| Collector-Emitter Voltage | VCES | 30 | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 30 | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 4 | 4.5 | |
| Collector Current — Continuous | lc | 100 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------|------|
| Thermal Resistance, Junction to Case | RAJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | RAJA | 200 | °C/W |

MPS4274 MPS4275

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

SWITCHING TRANSISTOR

NPN SILICON

Refer to MPS2369 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|-----------------|-------------------|------------------------------|----------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) MPS4274 MPS4275 | V(BR)CEO | 12 15 | = | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 10 µAdc, VEB = 0) MPS4274 MPS4275 | V(BR)CES | 30 40 | = | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 μ Adc, IE = 0) MPS4274 MPS4275 | V(BR)CBO | 30 40 | = | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 4.5 | _ | Vdc |
| Collector Cutoff Current (VCB = 20 Vdc, I _E = 0, T _A = 65°C) | ІСВО | _ | 10 | μAdc |
| Collector Cutoff Current (VCE = 20 Vdc, VEB = 0) | ICES | _ | 400 | nAdc |
| ON CHARACTERISTICS | | | | <u> </u> |
| DC Current Gain (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) (I _C = 30 mAdc, V _{CE} = 0.4 Vdc) (I _C = 100 mAdc, V _{CE} = 1.0 Vdc) | hFE | 35 30 18 | 120 — | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 30 mAdc, IB = 3.0 mAdc) (IC = 100 mAdc, IB = 10 mAdc) | VCE(sat) | = | 0.2 0.18 0.25 0.50 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 10 mAdc, I _B = 3.3 mAdc) (I _C = 30 mAdc, I _B = 3.0 mAdc) (I _C = 100 mAdc, I _B = 10 mAdc) | VBE(set) | 0.72 0.74 — | 0.85 1.00 1.15 1.60 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | L |
| Collector-Base Capacitance (VCB = 5.0 Vdc, f = 1.0 MHz) | C _{cb} | | 4.0 | ρF |
| Small Signal Current Gain (IC = 10 mAdc, VCB = 10 Vdc, f = 100 MHz) | h _{fe} | 4.0 | _ | |
| SWITCHING CHARACTERISTICS | | | | |
| Charge Storage Time (I _C = I _{B1} = I _{B2} = 10 mAdc, V _{CC} = 10 Vdc) | ts | | 13 | ns |
| Turn-On Time (I _C = 10 mAdc, I _{B1} = 3.3 mAdc, V _{CC} = 3.0 Vdc) | ton | | 12 | ns |
| Turn-Off Time (IC = 10 mAdc, IB1 = IB2 = 3.3 mAdc, VCC = 3.0 Vdc) | toff | - | 12 | ns |

(1) Pulse Test: Pulse Width ≤ 300 μSec, Duty Cycle ≤ 2.0%.

MPS5133

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MAXIMUM RATINGS | | | |
|---|-----------------------------------|-------------|-------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 18 | Vdc |
| Collector-Base Voltage | V _{CBO} | 20 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | .625 | Watts |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 | Watt |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |
| Lead Temperature (10 seconds) | TL | 260 | °C |

Refer to MPS3903 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|---------------------|-----------|------------|----------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Sustaining Voltage(1) (IC = 3.0 mA) | | | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 µA) | V(BR)CBO | 20 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μA) | V(BR)EBO | 3.0 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 15 V) (V _{CB} = 15 V, T _A = 65°C) | ІСВО | = | 50 5.0 | nA μA |
| Emitter Cutoff Current (VBE = 2.0 V) | IEBO | | 50 | nA |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 1.0 mA, V _{CE} = 5.0 V) | hFE | 60 | 1000 | - |
| Collector-Emitter Saturation Voltage (IC = 1.0 mA, Ig = 0.1 mA) | VCE(sat) | | 0.4 | Vdc |
| Base-Emitter On Voltage (I _C = 100 μA, V _{CE} = 5.0 V) | V _{BE(on)} | | 0.75 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Collector-Base Capacitance (VCB = 5.0 V) | C _{cb} | _ | 5.0 | pF |
| Small-Signal Current Gain (I _C = 1.0 mA, V _{CE} = 5.0 V, f = 1.0 kHz) (I _C = 1.0 mA, V _{CE} = 5.0 V, f = 20 MHz) | h _{fe} | 50 2.0 | 1100 20 | |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 1.0%.

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|-------|
| Collector-Emitter Voltage | VCEO | 30 | Vdc |
| Collector-Base Voltage | V _{CBO} | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | .625 | Watts |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 | Watt |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |
| Junction Temperature | TJ | | •€ |
| Lead Temperature (10 seconds) | Tı | 260 | °C |

MPS5138

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

TRANSISTOR

PNP SILICON

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|--|---------------------|----------------|---------------|----------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Sustaining Voltage(1) (IC = 10 mA) | V(BR)CEO(sus) | 30 | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µA) | V(BR)CBO | 30 | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 µA) | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 20 V) (V _{CB} = 20 V, T _A = 65°C) | ICBO | | 50 3.0 | nA μA |
| ON CHARACTERISTICS | | | | · · |
| DC Current Gain $(I_C = 100 \mu\text{A}, V_{CE} = 10 \text{V})$ $(I_C = 1.0 \text{mA}, V_{CE} = 10 \text{V})$ $(I_C = 10 \text{mA}, V_{CE} = 10 \text{V})(1)$ | ptE | 50 50 50 | 800 — — | _ |
| Collector-Emitter Saturation Voltage(1) (IC = 10 mA, Ig = 0.5 mA) | VCE(sat) | _ | 0.3 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 10 mA, Ig = 0.5 mA) | VBE(sat) | _ | 1.0 | Vdc |
| Base-Emitter On Voltage(1) (IC = 10 mA, VCE = 10 V) | V _{BE(on)} | | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Collector-Base Capacitance (VCB = 5.0 V, f = 1.0 MHz) | C _{cb} | _ | 7.0 | pF |
| Emitter-Base Capacitance (VBE = 0.5 V, f = 1.0 MHz) | C _{eb} | _ | 30 | pF |
| Small-Signal Current Gain (IC = 0.5 mA, V _{CE} = 5.0 V, f = 20 MHz) (IC = 1.0 mA, V _{CE} = 10 V, f = 1.0 kHz)) Pulse Test: Pulse Width ≤ 300 us. Duty Cycle ≤ 1.0% | h _{fe} | 1.5 40 | 1000 | _ |

Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 1.0%.

MPS5139

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

SWITCHING TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| WANISTON IDATING | | | |
|---|-----------------------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Base Voltage | VCBO | 20 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | ¹ C | 100 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.625 | Watts mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |
| Lead Temperature (10 seconds) | ΤL | 260 | °C |

| ELECTRICAL | CHARACTERISTICS | IT - 25°C unless | otherwise noted) |
|------------|-----------------|------------------|-------------------|
| | | | |

| Characteristic | Symbol | Min | Max | Unit |
|--|-----------------|----------------------|---------------------|----------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 100 µA) | V(BR)CES | 20 | - | Vdc |
| Collector-Emitter Sustaining Voltage (IC = 10 mA)(1) | VCEO(sus) | 20 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µA) | V(BR)CBO | 20 | - | Vdc |
| Emitter-Base Breakdown Voltage (Ig = 100 µA) | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 15 Vdc) (VCE = 15 Vdc, T _A = 65°C) | ICES | <u>-</u> | 50 25 | nA µA |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 100 μA, VCE = 10 Vdc) (IC = 1.0 mA, VCE = 10 Vdc) (IC = 10 mA, VCE = 1.0 Vdc)(1) (IC = 50 mA, VCE = 10 Vdc)(1) | hFE | 30 40 40 15 | - - - - | _ |
| Collector-Emitter Saturation Voltage (IC = 1.0 mA, IB = 0.1 mA)(1) (IC = 10 mA, IB = 1.0 mA)(1) (IC = 50 mA, IB = 5.0 mA)(1) | VCE(sat) | <u>-</u> | 0.15 0.20 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mA, I _B = 1.0 mA)(1) (I _C = 50 mA, I _B = 5.0 mA)(1) | VBE(sat) | 0.7 0.75 | 1.0 1.25 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | T. | |
| Collector-Base Capacitance (VCB = 10 Vdc, f = 1.0 MHz) | C _{cb} | _ | 5.0 | pF |
| Emitter-Base Capacitance (V _{BE} = 0.5 Vdc, f = 1.0 MHz) | C _{eb} | . – | 8.0 | pF |
| Current Gain — High Frequency (IC = 10 mA, VCE = 20 Vdc, f = 100 MHz) | h _{fe} | 3.0 | | |
| SWITCHING CHARACTERISTICS | | | | |
| Turn-On Time (I _C ~ 50 mA, I _{B1} ~ 5.0 mA) | ^t on | _ | 50 | ns |
| Turn-Off Time (IC ~ 50 mA, I _{B1} ~ 5.0 mA, I _{B2} ~ -5.0 mA) | toff | | 200 | ns |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 1.0%.

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 25 | Vdc |
| Collector-Base Voltage | V _{CBO} | 25 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 100 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------|------|
| Thermal Resistance, Junction to Case | RejC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | Raja | 200 | °C/W |

MPS5172

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MPS3903 for graphs.

| Characteristic | Symbol | Min | Тур | Max. | Unit |
|--|----------------------|-----|-------------|-----------|--------------|
| OFF CHARACTERISTICS | | | | | ٠. |
| Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, I _B = 0) | V(BR)CEO | 25 | _ | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 25 Vdc, I _E = 0) (V _{CB} = 25 Vdc, I _E = 0, T _A = 100°C) | ІСВО | _ | = | 100 10 | nAdc µAdc |
| Collector Cutoff Current (VCE = 25 Vdc, VBE = 0) | ICES | _ | _ | 100 | nAdc |
| Emitter Cutoff Current (VBE = 5.0 Vdc, IC = 0) | lEBO | - | - | 100 | nAdc |
| ON CHARACTERISTICS | | | | | ı |
| DC Current Gain(1) (IC = 10 mAde, VCE = 10 Vde) | hFE | 100 | _ | 500 | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | VCE(sat) | 1 | - | 0.25 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | V _{BE(sat)} | 1 | 0.75 | - | Vdc |
| Base-Emitter On Voltage (IC = 10 mAdc, VCE = 10 Vdc) | V _{BE(on)} | 0.5 | - | 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | <u> </u> |
| Current-Gain — Bandwidth Product (IC = 2.0 mAdc, VCE = 5.0 Vdc) | fī | _ | 120 | _ | MHz |
| Collector-Base Capacitance {VCB = 0, I _E = 0, f = 1.0 MHz} | C _{cb} | 1.6 | _ | 10 | pF |
| Small-Signal Current Gain (IC = 10 mAde, VCE = 10 Vdc, f = 1.0 kHz) | h _{fe} | 100 | - | 750 | _ |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MPS5179

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

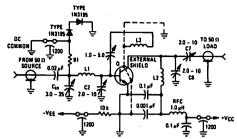
| MIAAMON ILATINGO | | | |
|---|------------------|-------------|------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 12 | Vdc |
| Collector-Base Voltage | VCBO | 20 | Vdc |
| Emitter-Base Voltage | VEBO | 2.5 | Vdc |
| Collector Current — Continuous | lc | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 200 1.14 | mW mW/℃ |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 300 1.71 | mW/°C |
| Storage Temperature Range | T _{sta} | -55 to +150 | °C |

| EL ECTRICAL | CHARACTERISTICS | /T 2 | F°C unlace | A baton poissonts |
|-----------------|-----------------|---------|------------|-------------------|
| FI FC: I RIE:AI | CHARACTERISTICS | IIA = 2 | o L uniess | otnerwise noted./ |

| Characteristic | Symbol | Min | Max | Unit |
|---|-----------------------|-----|-------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Sustaining Voltage (I _C = 3.0 mAdc, I _B = 0) | VCEO(sus) | 12 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.001 mAdc, IE = 0) | V(BR)CBO | 20 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 0.01 mAdc, I _C = 0) | V(BR)EBO | 2.5 | | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) (VCB = 15 Vdc, IE = 0, TA = 150°C) | ICBO | = | 0.02 1.0 | μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 3.0 mAdc, VCE = 1.0 Vdc) | hFE | 25 | 250 | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | VCE(sat) | _ | 0.4 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | V _{BE} (sat) | _ | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product(1) (I _C = 5.0 mAdc, V _{CE} = 6.0 Vdc, f = 100 MHz) | fτ | 900 | 2000 | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, IE = 0, f = 0.1 to 1.0 MHz) | . C _{cb} | | 1.0 | ρF |
| Small Signal Current Gain (I _C = 2.0 mAdc, V _{CE} = 6.0 Vdc, f = 1.0 kHz) | h _{fe} | 25 | 300 | _ |
| Collector Base Time Constant (IE = 2.0 mAdc, VCB = 6.0 Vdc, f = 31.9 MHz) | rb'C _C | 3.0 | 14 | ps |
| Noise Figure (See Figure 1) (I _C = 1.5 mAdc, V _{CE} = 6.0 Vdc, R _S = 50 ohms, f = 200 MHz) | NF | _ | 4.5 | qB |
| Common-Emitter Amplifier Power Gain (See Figure 1) (VCE = 6.0 Vdc, I _C = 5.0 mAdc, f = 200 MHz) | G _{pe} | 15 | | dB |

⁽¹⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.

FIGURE 1 – 200 MHz AMPLIFIER POWER GAIN AND NOISE FIGURE CIRCUIT



- L1 1-3/4 Turns, #18 AWG, 0.5" L, 0.5" Diameter L2 2 Turns, #18 AWG, 0.5" L, 0.5" Diameter L3 2 Turns, #13 AWG, 0.25" L, 0.5" Diameter (Position 1/4" from L2)

MPS6507

CASE 29-02, STYLE 2 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MAXIMUM RATINGS | | | |
|--|----------------------|-------------|---------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Base Voltage | V _{CBO} | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | lc | 100 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | င္ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|----------------------|------|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 200 | °C/W |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|------------------|----------|--------------|--------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (I _C = 1.0 mAdc, I _B = 0) | V(BR)CEO | 20 | _ | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 30 | _ | - | Vdc |
| Emitter-Base Breakdown Voltage (Ig = 100 μAdc, IC = 0) | V(BR)EBO | 3.0 | - | _ | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) (VCB = 15 Vdc, IE = 0, TA = 60°C) | СВО | <u>-</u> | <u> </u> | 50 1.0 | nAdc μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(2) (IC = 2.0 mAdc, VCE = 10 Vdc) | hFE | 25 | 75 | | _ |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 10 Vdc, f = 100 MHz) | fτ | 700 | 800 | | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | _ | 1.25 | 2.5 | pF |
| Small-Signal Current Gain (IC = 2.0 mAdc, VCE = 10 Vdc, f = 44 MHz) | h _{fe} | 20 | | _ | |

⁽²⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|--------------|
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Emitter Voltage | VCES | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | Ic | 100 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12.0 | Watt mW/℃ |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | ပ္ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|----------------------|------|------|
| Thermal Resistance, Junction to Case | ReJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 200 | °C/W |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

MPS6511

CASE 29-02, STYLE 2 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|------------------|-----|--------|-----|--|
| OFF CHARACTERISTICS | | | 1 - 11 | | 1 |
| Collector-Emitter Breakdown Voltage(2) (I _C = 0.5 mAdc, I _B = 0) | V(BR)CEO | 20 | _ | _ | Vdc |
| Collector-Emitter Breakdown Voltage(2) (I _C = 100 μAdc, V _{EB} = 0) | V(BR)CES | 30 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) | ісво | _ | | 50 | nAdc |
| ON CHARACTERISTICS | | | L | L | <u>. </u> |
| DC Current Gain(2) (IC = 10 mAdc, VCE = 10 Vdc) | hFE | 25 | 75 | | <u> </u> |
| SMALL-SIGNAL CHARACTERISTICS | | | · | | L |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | _ | 1.25 | 2.5 | pF |
| FUNCTIONAL TEST | | | L | · | |
| Amplifier Power Gain (I _C = 10 mAdc, V _{CB} = 12 Vdc, f = 45 MHz) | G _{pe} | 30 | _ | _ | dB |

⁽²⁾ Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

NPN MPS6512 thru MPS6515 PNP MPS6516 thru MPS6519

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

Refer to 2N4125 for graphs.

MAYIMUM BATINGS

| MAXIMUM RATINGS | | | | |
|--|-----------------------------------|------------|---------|----------------|
| Rating | Symbol | NPN | PNP | Unit |
| Collector-Emitter Voltage | VCEO | | | Vdc |
| MPS6512, MPS6513 | | 30 25 | _ | |
| MPS6514, MPS6515 | | 25 | 40 | ì |
| MPS6516 thru MPS6518 MPS6519 | | | 25 | |
| Collector-Base Voltage | V _{CBO} | | | Vdc |
| MPS6512 thru MPS6515 | 000 | 40 | | |
| MPS6516 thru MPS6518 | | | 40 | |
| MPS6519 | | - | 25 | |
| Emitter-Base Voltage | VEBO | 4.0 | 4.0 | Vdc |
| Collector Current — Continuous | lc | 100 | 100 | mAdc |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 625 5.0 | | mW mW/℃ |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | | .5 2 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 55 to | + 150 | °C |

THERMAL CHARACTERISTICS

| I LIEUMAE OI MINO I EI IIO 1100 | | | |
|---|-------------------|------|------|
| Characteristic | Symbol | Max | Unit |
| Thermal Resistance, Junction to Case | R _{ØJC} | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _Ø JA | 200 | °CW |

| ELECTRICAL CHARACTERISTICS (TA = 25 | 5°C unless otherwise noted.) | | | | | |
|--|--|----------|------------------------|---|---|------|
| Characteristic | | Symbol | Min | Тур | Max | Unit |
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 0.5 mAdc, IB = 0) | MPS6512, MPS6513 MPS6514, MPS6515 | V(BR)CEO | 30 25 | = | <u>-</u> , | Vdc |
| $(I_C = 0.5 \text{ mAdc}, I_B = 0)$ | MPS6516 thru MPS6518 MPS6519 | | 40 25 | = | _ | |
| Emitter-Base Breakdown Voltage (IE = 10 μ A) (IE = 10 μ A) | Adc, IC = 0) | V(BR)EBO | 4.0 4.0 | | - 1 | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0) (VCB = 30 Vdc, IE = 0) (VCB = 20 Vdc, IE = 0) | MPS6516 thru MPS6518 MPS6519 | ICBO | - - - | | 0.05 0.05 0.05 | μAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain (I _C = 2.0 mAdc, V _{CE} = 10 Vdc) | MPS6512 MPS6513 MPS6514 MPS6515 | hFE | 50 90 150 250 | ======================================= | 100 180 300 500 | _ |
| $\{I_{C} = 100 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}\}(1)$ | MPS6512 MPS6513 MPS6514 MPS6515 | | 30 60 90 150 | 1 1 1 | _ _ _ | |
| (I _C = 2.0 mAdc, V _{CE} = 10 Vdc) | MPS6516 MPS6517 MPS6518 MPS6519 | | 50 90 150 250 | _ _ _ | 100 180 300 500 | |
| $\{I_{C} = 100 \text{ mAdc, } V_{CE} = 10 \text{ Vdc}\}(1)$ | MPS6516 MPS6517 MPS6518 MPS6519 | | 30 60 90 150 | _ _ _ | ======================================= | |
| Collector-Emitter Saturation Voltage (IC = 5 (IC = 5 | i0 mAdc, IB = 5.0 mAdc) i0 mAdc, IB = 5.0 mAdc) | VCE(sat) | = | | 0.5 0.5 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, (V _{CB} = 10 Vdc, I _E = 0, | f = 100 kHz) f = 100 kHz) | Cobo | | | 3.5 4.0 | pF |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| IVIAAIIVIOIVI RATIIVOS | | | | |
|---|-----------------------------------|------------|----------|----------------|
| Rating | Symbol | NPN | PNP | Unit |
| Collector-Emitter Voltage MPS6520, MPS6521 | VCEO | 25 | | Vdc |
| MPS6522, MPS6523 | | _ | 25 | |
| Collector-Base Voltage | V _{CBO} | | | Vdc |
| MPS6520, MPS6521 | 1 | 40 | – | 1 |
| MPS6522, MPS6523 | } | _ | 25 | |
| Emitter-Base Voltage | VEBO | 4 | .0 | Vdc |
| Collector Current — Continuous | ľc | 100 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 55 to | + 150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|--|--------|------|------|
| Thermal Resistance, Junction to Ambient (Printed Circuit Board Mounting) | Reja | 200 | °C/W |
| Thermal Resistance, Junction to Case | RøJC | 83.3 | •c/w |

NPN MPS6520 MPS6521

PNP MPS6522 MPS6523

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

Refer to MPS3903 for NPN graphs.*

| Characteristi | c | Symbol | Min | Max | Unit |
|---|--------------------------|------------------|------------|--------------|----------|
| OFF CHARACTERISTICS | | | | | <u> </u> |
| Collector-Emitter Breakdown Voltage (I _C = 0.5 mAdc, I _B = 0) (I _C = 0.5 mAdc, I _B = 0) | | V(BR)CEO | 25 25 | = | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) (IE = 10 µAdc, IC = 0) | - | V(BR)EBO | 4.0 4.0 | = | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, $I_E = 0$) (VCB = 20 Vdc, $I_E = 0$) | | ІСВО | = | 0.05 0.05 | μAdc |
| ON CHARACTERISTICS | | | | - | |
| DC Current Gain (IC = 100 μAdc, V _{CE} = 10 Vdc) | MPS6520 MPS6521 | PEE | 100 150 | | _ |
| (I _C = 2.0 mAdc, V _{CE} = 10 Vdc) | MPS6520 MPS6521 | | 200 300 | 400 600 | |
| (IC = 100 μ Adc, V _{CE} = 10 Vdc) | MPS6522 MPS6523 | | 100 150 | 400 | |
| (I _C = 2.0 mAdc, V _{CE} = 10 Vdc) | MPS6522 MPS6523 | | 200 300 | 600 | |
| Collector-Emitter Saturation Voltage (IC = 50 mAdc, Ig = 5.0 mAdc) (IC = 50 mAdc, Ig = 5.0 mAdc) | | VCE(sat) | | 0.5 0.5 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Output Capacitance (V _{CB} = 10 Vdc, I_E = 0, f = 100 kHz) (V _{CB} = 10 Vdc, I_E = 0, f = 100 kHz) | | C _{obo} | - | 3.5 3.5 | ρF |
| Noise Figure (I _C = 10 µAdc, V _{CE} = 5.0 Vdc, R _S = 10 kohm Power Bandwidth = 15.7 kHz, 3.0 dB points @ | is, 10 Hz and 10 kHzi | NF | _ | 3.0 | dB |
| (I _C = 10 μAdc, V _{CE} = 5.0 Vdc, R _S = 10 kohm Power Bandwidth = 15.7 kHz, 3.0 dB points @ | 15, | | - | 3.0 | |

^{*}Refer to 2N5086 for PNP graphs.

MPS6530 thru MPS6532

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|----------|----------|------|
| Collector-Emitter Voltage MPS6530, MPS6531 MPS6532 | VCEO | 40 30 | Vdc |
| Collector-Base Voltage MPS6530, MPS6531 MPS6532 | VCBO | 60 50 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 600 | mAdd |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 | mW |
| Junction Temperature | TJ, Tsta | 150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|-----|-------|
| Thermal Resistance, Junction to Ambient | RAIA | 0.2 | °C/mW |

Refer to 2N4400 for graphs.

| Characteristi | <u> </u> | Symbol | Min | Max | Unit |
|--|-------------------------------|----------------------|----------------|-----------------|----------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 10 mAdc, IB = 0) | MPS6530, MPS6531 MPS6532 | V(BR)CEO | 40 30 | - - | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | MPS6530, MPS6531 MPS6532 | V(BR)CBO | 60 50 | | Vdc |
| Emitter-Base Breakdown Voltage (I _B = 10 μAdc, I _C = 0) (I _B = 10 μAdc, I _C = 0) | All Types All Types | V(BR)EBO | 5.0 4.0 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 40 Vdc, I _E = 0) (V _{CB} = 30 Vdc, I _E = 0) | MPS6530, MPS6531 MPS6532 | ICBO . | = | 0.05 0.1 | μAdc |
| (V _{CB} = 40 Vdc, I _E = 0, T _A = 60°C) (V _{CB} = 30 Vdc, I _E = 0, T _A = 60°C) | MPS6530, MPS6531 MPS6532 | | | 2.0 5.0 | <u> </u> |
| ON CHARACTERISTICS | | - 1 | | | Τ |
| DC Current Gain (IC = 10 mAdc, VCE = 1.0 Vdc) | MPS6530 MPS6531 | PE | 30 60 | _ | |
| (I _C = 100 mAdc, V _{CE} = 1.0 Vdc) | MPS6530 MPS6531 MPS6532 | | 40 90 30 | 120 270 — | |
| (I _C = 500 mAdc, V _{CE} = 10 Vdc) | MPS6530 MPS6531 | | 25 50 | | |
| Collector-Emitter Saturation Voltage (I _C = 100 mAdc, I _B = 10 mAdc) | MPS6530, MPS6532 MPS6531 | V _{CE(sat)} | 11 | 0.5 0.3 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 100 mAdc, I _B = 10 mAdc) | MPS6530, MPS6531 MPS6532 | VBE(sat) | _ | 1.0 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | All Types All Types | C _{obo} | = | 5.0 7.0 | pF |

| Rating | Symbol | Value | Unit |
|---|----------|----------|------|
| Collector-Emitter Voltage MPS6533, MPS6534 MPS6535 | VCEO | 40 30 | Vdc |
| Collector-Base Voltage MPS6533, MPS6534 MPS6535 | VCBO | 40 30 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | lc | 600 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 | mW |
| Junction Temperature | TJ, Tsta | 150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|-----|-------|
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 0.2 | °C/mW |

MPS6533 thru MPS6535

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

PNP SILICON

Refer to 2N4402 for graphs.

| Characterist | tic | Symbol | Min | Max | Unit |
|--|--|------------------|----------------|---------------|-------------|
| OFF CHARACTERISTICS | - | | | * | |
| Collector-Emitter Breakdown Voltage (IC = 10 mAdc, IB = 0) | MPS6533, MPS6534 MPS6535 | V(BR)CEO | 40 30 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 µAdc, I _E = 0) | MPS6533, MPS6534 MPS6535 | V(BR)CBO | 40 30 | = | Vdc |
| Emitter-Base Breakdown Voltage (I _B = 10 μAdc, I _C = 0) (I _B = 10 μAdc, I _C = 0) | All Types All Types | V(BR)EBO | 5.0 4.0 | | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0) | All Types | СВО | _ | 0.05 | μAdc |
| (VCB = 30 Vdc, IE = 0, TA = 60°C) (VCB = 20 Vdc, IE = 0, TA = 60°C) | MPS6533, MPS6534 MPS6535 | | _ | 2.0 5.0 | |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) (I _C = 100 mAdc, V _{CE} = 1.0 Vdc) | MPS6533 MPS6534 MPS6533 | ptE | 30 60 40 | 120 | |
| (IC = 500 mAdc, VCE = 10 Vdc) | MPS6534 MPS6535 MPS6533 | | 90 30 25 | 270 — — | |
| Collector-Emitter Saturation Voltage (I _C = 100 mAdc, I _B = 10 mAdc) | MPS6534 MPS6533, MPS6535 MPS6534 | VCE(sat) | | 0.5 0.3 | Vdc |
| Base-Emitter Saturation Voltage (IC = 100 mAdc, IB = 10 mAdc) | MPS6533, MPS6534 MPS6535 | VBE(sat) | | 1.0 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | All Types All Types | C _{obo} | | 5.0 7.0 | pF |

MPS6543

CASE 29-02, STYLE 2 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MAYIMOM UNTINGO | | | |
|---|----------------------|-------------|---------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 25 | Vdc |
| Collector-Base Voltage | VCBO | 35 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | lc | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | Tj, T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|---------|-----|------|
| Thermal Resistance, Junction to Case | Rajc | 125 | °C/W |
| Thermal Resistance, Junction to Ambient | ReJA(1) | 357 | °C/W |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|----------------------|-----|------|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (I _C = 1.0 mAdc, I _B = 0) | V(BR)CEO | 25 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 35 | _ | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 µAdc, I _C = 0) | V(BR)EBO | 3.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 25 Vdc, I _E = 0) | ІСВО | - | _ | 0.1 | μAdc |
| Emitter Cutoff Current (VBE = 2.0 Vdc, IC = 0) | IEBO | _ | | 1.0 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(2) (I _C = 4.0 mAdc, V _{CE} = 10 Vdc) | hFE | 25 | 60 | - | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | VCE(sat) | _ | 200 | 350 | mVdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | V _{BE(sat)} | | 750 | 950 | mVdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 4.0 mAdc, VCE = 12 Vdc, f = 100 MHz) | fτ | 750 | 1100 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | C _{obo} | _ | 0.8 | 1.0 | pF |
| Collector Base Time Constant (IE = 4.0 mAdc, VCE = 12 Vdc, f = 31.8 MHz) | rb'C _c | _ | _ | 9.5 | ps |

⁽²⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|-------------|
| Collector-Emitter Voltage | VCEO | 45 | Vdc |
| Collector-Base Voltage | V _{CBO} | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 2.81 | mW mW/°C |
| Total Device Dissipation @ TA = 60°C | PD | 210 | mW |
| Operating and Storage Junction Temperature Range | TJ, Tstg | -55 to +135 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|-----|------|
| Thermal Resistance, Junction to Ambient | RAJA | 357 | °C/W |

MPS6544

CASE 29-02, STYLE 2 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MPSH20 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|------------------|-----|----------|-------|
| OFF CHARACTERISTICS | | | | 1 |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, IE = 0) | V(BR)CEO | 45 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 μAdc, IE = 0) | V(BR)CBO | 60 | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 4.0 | | Vdc |
| Collector Cutoff Current (VCB = 35 Vdc, I _E = 0) | 1CBO | _ | 0.5 | μAdc |
| ON CHARACTERISTICS | | | <u> </u> | |
| DC Current Gain (IC = 30 mAdc, VCE = 10 Vdc) | hFE | 20 | _ | - |
| Collector-Emitter Saturation Voltage (IC = 30 mAdc, Ig = 3.0 mAdc) | VCE(sat) | _ | 0.5 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | ٠ | |
| Common-Emitter Reverse Transfer Capacitance (VCB = 10 Vdc, IC = 0, f = 100 kHz) | C _{re} | _ | 0.65 | pF |
| Output Admittance (IC = 10 mAdc, VCE = 10 Vdc, f = 45 MHz) | Yoe | _ | 0.10 | mmhos |
| Output Voltage (Vin(RMS) = 12 mV, f = 45 MHz) | V _{out} | 1.0 | - | Vdc |

MPS6547

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|----------------------|-------------|---------------|
| Collector-Emitter Voltage | VCEO | 25 | Vdc |
| Collector-Base Voltage | V _{CBO} | 35 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | lc | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12.0 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | Tj, T _{stg} | -55 to +150 | °C |

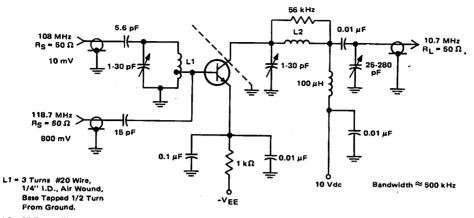
THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|----------------------|------|------|
| Thermal Resistance, Junction to Case | R _Ø JC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 200 | °C/W |

⁽¹⁾ Raja is measured with the device soldered into a typical printed circuit board.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|-----------------|-----|------|------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 25 | - | | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 35 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (p = 100 µAdc, C = 0) | V(BR)EBO | 3.0 | | _ | Vdc |
| Collector Cutoff Current (VCB = 25 Vdc, IE = 0) | ICBO | | _ | 100 | nAdc |
| Emitter Cutoff Current (VgE = 2.0 Vdc, IC = 0) | IEBO | | | 1.0 | μAdc |
| ON CHARACTERISTICS | | , | | | |
| DC Current Gain (I _C = 2.0 mAdc, V _{CE} = 5.0 Vdc) | hFE | 20 | 60 | | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | VCE(sat) | | 0.1 | 0.35 | Vdc |
| Base-Emitter On Voltage(2) (IC = 10 mAdc, VCE = 10 Vdc) | VBE(on) | | 0.7 | 0.95 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | Υ | | |
| Current-Gain — Bandwidth Product (I _C = 2.0 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | fτ | 600 | 1000 | | MHz |
| Common-Emitter Reverse Transfer Capacitance (VCB = 10 Vdc, Ig = 0, f = 100 kHz) | C _{re} | | 0.3 | 0.35 | pF |
| Conversion Gain (I _C = 4.0 mAdc, V _{CE} = 10 Vdc, f = 100 MHz to 10.7 MHz) | G _{pe} | 20 | 25 | | dB |

⁽²⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.



L2 = 37 Turns #28 Wire, Wound on 1/4" I.D. Coil Form.

MPS6560 MPS6562

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AUDIO TRANSISTOR

MPS6560 NPN SILICON

MPS6562 PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 25 | Vdc |
| Collector-Base Voltage | V _{CBO} | 25 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 500 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| THE WAR OF PROPERTY OF THE PARTY | | |
|--|---------|------|-------|
| Characteristic | Symbol | Max | Unit |
| Thermal Resistance, Junction to Case | RAJC | 83.3 | °C/mW |
| Thermal Resistance, Junction to Ambient | Raja(1) | 200 | °C/mW |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|----------------|-----|------|
| OFF CHARACTERISTICS | | <u></u> | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, Ig = 0) | V(BR)CEO | _ | 25 | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | | 25 | Vdc |
| Emitter-Base Breskdown Voltage (IE = 100 µAdc, IC = 0) | V(BR)EBO | 5.0 | | Vdc |
| Collector Cutoff Current (VCE = 25 Vdc, IB = 0) | ICEO | | 100 | nAdc |
| Collector Cutoff Current (V _{CB} = 20 Vdc, I _E = 0) | ІСВО | | 100 | nAdc |
| Emitter Cutoff Current (VEB(off) = 4.0 Vdc, IC = 0) | ¹ EBO | | 100 | nAdc |
| ON CHARACTERISTICS(2) | | | | |
| DC Current Gain (IC = 10 mAdc, V _{CE} = 1.0 Vdc) (IC = 100 mAdc, V _{CE} = 1.0 Vdc) (IC = 500 mAdc, V _{CE} = 1.0 Vdc) | hFE | 35 50 50 | 200 | _ |
| Collector-Emitter Saturation Voltage (I _C = 500 mAdc, I _B = 50 mAdc) | VCE(sat) | | 0.5 | Vdc |
| Base-Emitter On Voltage (IC = 500 mAdc, VCE = 1.0 Vdc) | VBE(on) | | 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 30 MHz) | fτ | 60 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | C _{obo} | _ | 30 | pF |

⁽²⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| INDUMON INTINGO | | | |
|---|-----------------------------------|-------------|-------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 45 | Vdc |
| Collector-Base Voltage | VCBO | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | lc | 200 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Case | Rejc | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 200 | °C/W |

MPS6565 MPS6566

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N3903 for graphs.

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|--------------------|------------------|-----------|-----|------------|------|
| OFF CHARACTERISTICS | | | | | - | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) | | V(BR)CEO | 45 | - | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μAdc, IE = 0) | | V(BR)CBO | 60 | - | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 µAdc, I _C = 0) | | V(BR)EBO | 4.0 | | - | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0) | · | ІСВО | _ | | 100 | nAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain (IC = 10 mAdc, V _{CE} = 10 Vdc) | MPS6565 MPS6566 | hFE | 40 100 | = | 160 400 | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | | VCE(sat) | _ | 0.1 | 0.4 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | - | C _{obo} | | _ | 3.5 | pF |

MPS6568A thru MPS6570A

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

VHF TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|---------------|
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Base Voltage | VCBO | 20 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | lc | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | ℃ |

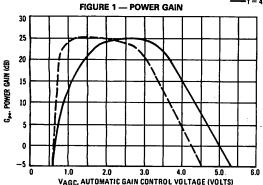
THERMAL CHARACTERISTICS

| ſ | Characteristic | Symbol | Max | Unit |
|---|---|------------------|------|------|
| Ì | Thermal Resistance, Junction to Case(1) | R _{ØJC} | 83.3 | °C/W |
| t | Thermal Resistance, Junction to Ambient | RAJA | 200 | °C/W |

⁽¹⁾ Raya is measured with the device soldered into a typical printed circuit board.

| Characteristic | | Symbol | Min | Max | Unit |
|--|----------------------------------|----------------------|-------------------|-------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, Ig = 0) | | V(BR)CEO | 20 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | | V(BR)CBO | 20 | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 3.0 | _ | Vđc |
| Collector Cutoff Current (VCB = 10 Vdc, IC = 0) | | ІСВО | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (t _C = 4.0 mAdc, V _{CE} = 5.0 Vdc) | | hFE | 20 | 200 | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 5.0 mAdc) | | V _{CE(sat)} | 0.1 | 3.0 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 5.0 mAdc) | | V _{BE(sat)} | _ | 0.96 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (I _C = 4.0 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | MPS6568A MPS6569A, MPS6570A | fī | 375 300 | 800 800 | MHz |
| Collector-Base Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz, emitter guarded) | MPS6568A/6570A | C _{cb} | _ | 0.65 | pF |
| Noise Figure (VAGC = 1.4 Vdc, R _S = 50 ohms, f = 200 MHz) (VAGC = 2.75 Vdc, R _S = 50 ohms, f = 45 MHz) FUNCTIONAL TEST | MPS6568A MPS6569A, MPS6570A | NF | = | 3.3 6.0 | dB |
| Amplifier Power Gain | | Gpe | | | dB |
| (VAGC = 1.4 Vdc, R _S = 50 ohms, f = 200 MHz) (VAGC = 2.75 Vdc, R _S = 50 ohms, f = 45 MHz) | MPS6568A MPS6569A, MPS6570A | P 0 | 20 22.5 | 27 28.5 | |
| Forward AGC Voltage (Gein Reduction = 30 dB, R _S = 50 ohms, f = 200 MHz) (Gain Reduction = 30 dB, R _S = 50 ohms, f = 45 MHz) | MPS6568A MPS6569A MPS6570A | VAGC | 4.0 4.4 5.2 | 5.0 5.4 6.2 | Vdc |

AGC CHARACTERISTICS $V_{CC} = 12 \text{ Vdc}, R_S = 50 \text{ OHMS}, SEE FIGURES 9 AND 10}$ -f = 45 MHz -- f = 200 MHz



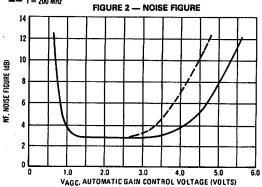


FIGURE 3 - 200 MHz FUNCTIONAL TEST CIRCUIT (NEUTRALIZED)

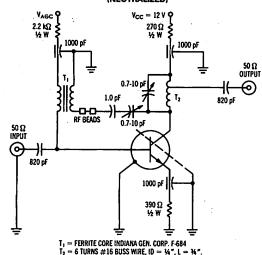
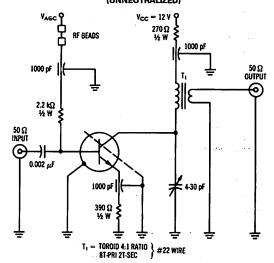


FIGURE 4 — 45 MHz FUNCTIONAL TEST CIRCUIT (UNNEUTRALIZED)



MPS6571

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Reting | Symbol | Value | Unit |
|---|-----------------------------------|-------------|---------------|
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Base Voltage | VCBO | 25 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | lc | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/℃ |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 200 | °C⁄W |
| Thermal Resistance, Junction to Case | RøJC | 83.3 | °C⁄W |

Refer to MPSA18 for graphs.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|---------------------|-----|-----|------|------|
| OFF CHARACTERISTICS | | | | | , |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) | V(BR)CEO | 20 | - | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 µAdc, I _E = 0) | V(BR)CBO | 25 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 20 Vdc, IE = 0) | СВО | - | - | 50 | nAdc |
| Emitter Cutoff Current (VEB(off) = 3.0 Vdc, IC = 0) | IEBO | _ | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 100 μAdc, V _{CE} = 5.0 Vdc) | hFE | 250 | | 1000 | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | VCE(sat) | _ | _ | 0.5 | Vdc |
| Base-Emitter On Voltage (IC = 10 mAdc, VCE = 5.0 Vdc) | V _{BE(on)} | _ | _ | 0.8 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (t _C = 500 μAdc, V _{CE} = 5.0 Vdc, f = 20 MHz) | fŢ | 50 | 175 | _ | MHz |
| Output Capacitance (VCB = 5.0 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | | - | 4.5 | pF |
| Noise Figure (I _C = 100 μAdc, V _{CE} = 5.0 Vdc, R _S = 10 kohms, f = 100 Hz) | NF | _ | 1.2 | _ | dB |

| Rating | Symbol | MPS6573 MPS6574 | MPS6575 MPS6576 | |
|---|----------|--------------------|--------------------|---------------|
| Collector-Emitter Voltage | VCEO | 35 | 45 | Vdc |
| Collector-Base Voltage | VCBO | 35 | 45 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | | Vdc |
| Collector Current — Continuous | lc | 100 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | | Watt mW/°C |
| Operating and Storage Junction Temperature Range | TJ, Tstg | - 55 to | -55 to +150 | |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|----------------------|------|-------|
| Thermal Resistance, Junction to Case | ReJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 200 | °C/W. |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

MPS6573 thru MPS6576

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AUDIO TRANSISTOR

NPN SILICON

Refer to MPS3903 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|--|---|----------|-------------------|------------|------|
| OFF CHARACTERISTICS | | | *** | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 1.0 mAdc, IB = 0) | MPS6573, MPS6574 MPS6575, MPS6576 | V(BR)CEO | 35 45 | = | Vdc |
| Collector Cutoff Current $(VCB = 35 \ Vdc, _E = 0)$ $\{VCB = 45 \ Vdc, _E = 0\}$ | MPS6573, MPS6574 MPS6575, MPS6576 | ІСВО | _ | 100 100 | nAdc |
| Emitter Cutoff Current (VEB = 4.0 Vdc, I _C = 0) | | IEBO | | 100 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 100 µAdc, V _{CE} = 5.0 Vdc) (I _C = 10 mAdc, V _{CE} = 5.0 Vdc)(2) (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc) | MPS6573, MPS6575 MPS6573, MPS6575 MPS6574, MPS6576(2) | hFE | 100 200 100 | 500 300 | - |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | | VCE(sat) | _ | 0.5 | Vdc |
| Base-Emitter On Voltage(2) (IC = 10 mAdc, V _{CE} = 5.0 Vdc) | | VBE(on) | _ | 0.8 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product(2) (IC = 10 mAdc, VCE = 5.0 Vdc, f = 100 kHz) | | fΤ | 100 | 350 | MHz |
| Output Capacitance (VCB = 12 Vdc, IE = 0, f = 100 kHz) | | Cobo | _ | 12 | pF |

(2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MPS6580

CASE 29-02, STYLE 2 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| MAXIMOM IN INGS | | | |
|---|----------------------|-------------|---------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 25 | Vdc |
| Collector-Base Voltage | V _{CBO} | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | lc . | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12.0 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{Stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|---------|------|------|
| Thermal Resistance, Junction to Case | RAJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | Raja(1) | 200 | °C/W |

(1) R_{BJA} is measured with the device soldered into a typical printed circuit board.

Refer to MPSH81 for graphs.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|-----------------|----------|------------|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 1.0 mAdc, Ig = 0) | V(BR)CEO | 25 | _ | 1 | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 30 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | V(BR)EBO | 3.0 | - | | Vdc |
| Collector Cutoff Current (VCB = 20 Vdc, I _E = 0) | ICBO | _ | _ | 100 | nAdc |
| Emitter Cutoff Current (VBE = 2.0 Vdc, I _C = 0) | IEBO | - | - - | 100 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(2) (I _C = 2.0 mAdc, V _{CE} = 10 Vdc) | hFE | 20 | 80 | _ | _ |
| Collector-Emitter Saturation Voltage (IC = 2.0 mAde, Ig = 0.2 mAde) | VCE(sat) | _ | 0.2 | 0.5 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (I _C = 2.0 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | fτ | 250 | 450 | _ | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, IE = 0, f = 100 MHz) | C _{cb} | _ | 0.5 | 1.0 | pF |

⁽²⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage MPS6601/6651 MPS6602/6652 | VCEO | 25 40 | Vdc |
| Collector-Base Voltage MPS6601/6651 MPS6602/6652 | УСВО | 25 30 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | lc | 1000 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

OFF CHARACTERISTICS

 $(I_C = 1.0 \text{ mAdc}, I_B = 0)$

Collector-Emitter Breakdown Voltage

| Characteristic | Symbol | Max | Unit |
|---|----------------------|------|------|
| Thermal Resistance, Junction to Case | ReJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 200 | °C/W |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.) Characteristic

NPN MPS6601 MPS6602 PNP MPS6651 MPS6652

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

Max

0.6

1.2

Unit

Vdc

Vdc

Vdc

Min

25

Symbol

V(BR)CEO

V_{CE(sat)}

VBE(on)

| Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0) | MPS6601/6651 MPS6602/6652 | V(BR)CBO | 25 40 | = | Vdc |
|---|------------------------------|----------------------|----------------|------------|------|
| (IE = 10 μAdc, IC = 0) | | V _{(BR)EBO} | 4.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 25 Vdc, Ig = 0) (VCE = 30 Vdc, Ig = 0) | MPS6601/6651 MPS6602/6652 | ICEO | | 0.1 0.1 | μAdc |
| Collector Cutoff Current (VCB = 25 Vdc, I _E = 0) (VCB = 30 Vdc, I _E = 0) | MPS6601/6651 MPS6602/6652 | Ісво | | 0.1 0.1 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (Ic = 100 mAdc, VCE = 1.0 Vdc) (IC = 500 mAdc, VCE = 1.0 Vdc) (IC = 1000 mAdc, VCE = 1.0 Vdc) | | hfE | 50 50 30 | = | _ |

MPS6601/6651

MPS6602/6652

| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 10 Vdc, f = 30 MHz) | fτ | 100 | _ | MHz |
|--|------------------|-----|----|-----|
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | C _{obo} | - | 30 | pF |
| SWITCHING CHARACTERISTICS | | | | • |

| SWITC | HING | CHA | RACT | ERIS | пcs |
|-------|------|-----|------|------|-----|
| | | | | | |
| | | | | | |

Collector-Emitter Saturation Voltage

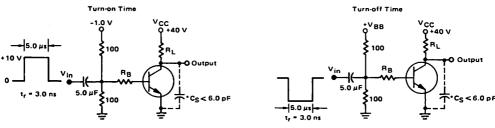
Base-Emitter On Voltage

(IC = 1000 mAdc, IB = 100 mAdc)

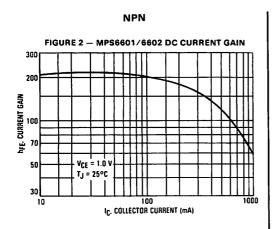
(IC = 500 mAdc, VCE = 1.0 Vdc) **SMALL-SIGNAL CHARACTERISTICS**

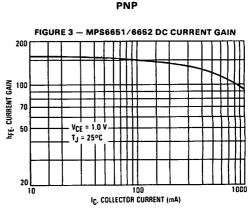
| Delay Time | t _d | | 25 | ns |
|--|----------------------|---|-----|----|
| Rise Time (VCC = 40 Vdc, IC | = 500 mAdc, | _ | 30 | ns |
| Storage Time B1 = 50 mAdc, t _D ≥ 300 ns Duty 0 | ycle) t _s | _ | 250 | ns |
| Fall Time | ч | _ | 50 | ns |

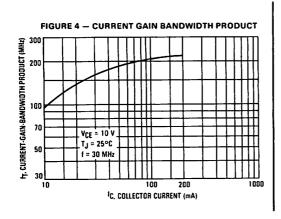
FIGURE 1 - SWITCHING TIME TEST CIRCUITS

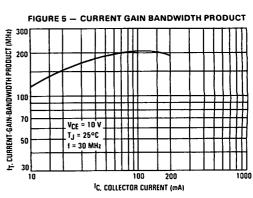


*Total Shunt Capacitance of Test Jig and Connectors For PNP Test Circuits, Reverse All Voltage Polarities

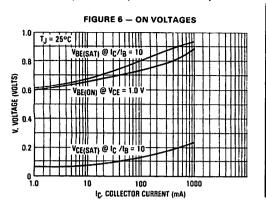


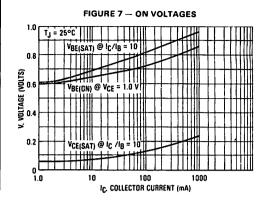


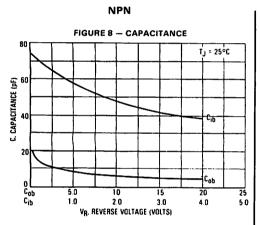


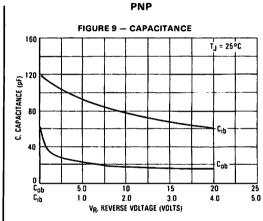


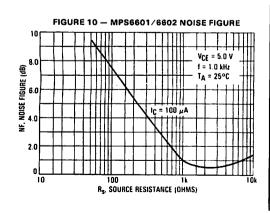
NPN MPS6601, MPS6602, PNP MPS6651, MPS6652

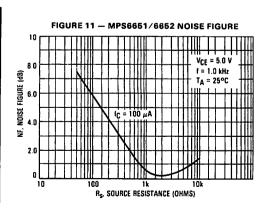




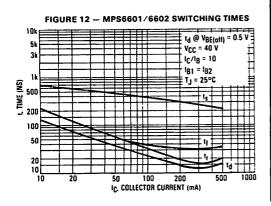


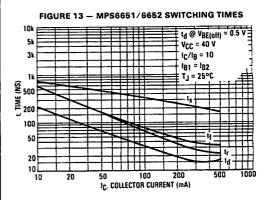


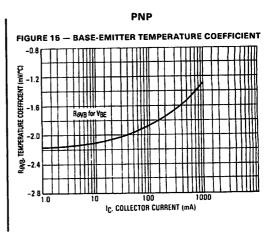


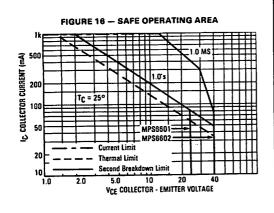


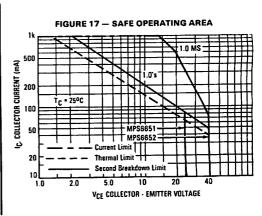
NPN MPS6601, MPS6602, PNP MPS6651, MPS6652



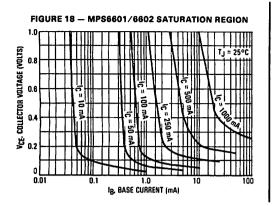


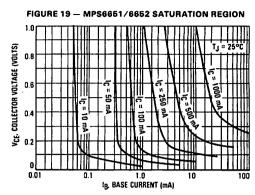


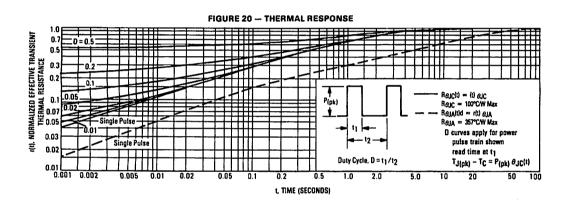




NPN MPS6601, MPS6602, PNP MPS6651, MPS6652







MPS6714 MPS6715

CASE 29-03, STYLE 1 TO-92 (TO-226 AE)

AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage MPS6714 MPS6715 | VCEO | 30 40 | Vdc |
| Collector-Base Voltage MPS6714 MPS6715 | VCBO | 40 50 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | 1C | 1.0 | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.5 20 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|-----|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 50 | °C/W |
| Thermal Resistance, Junction to Ambient | RAIA | 125 | °C/W |

Refer to MPSW01 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------|---------------------|----------|------------|------|
| OFF CHARACTERISTICS | • | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, Ig = 0) | MPS6714 MPS6715 | V(BR)CEO | 30 40 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μAdc, IE = 0) | MPS6714 MPS6715 | V(BR)CBO | 40 50 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 40 Vdc, I _E = 0) (V _{CB} = 50 Vdc, I _E = 0) | MPS6714 MPS6715 | ICBO | <u>-</u> | 0.1 0.1 | μAdc |
| Emitter Cutoff Current (VEB = 5.0 Vdc, IC = 0) | | IEBO | _ | 0.1 | μAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain (IC = 100 mAdc, VCE = 1.0 Vdc) (IC = 1000 mAdc, VCE = 1.0 Vdc) | | hFE | 60 50 | _ 250 | _ |
| Collector-Emitter Saturation Voltage (IC = 1000 mAdc, IB = 100 mAdc) | | VCE(sat) | _ | 0.5 | Vdc |
| Base-Emitter On Voltage {IC = 1000 mAdc, VCE = 1.0 Vdc} | | V _{BE(on)} | _ | 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Collector-Base Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | | C _{cb} | _ | 30 | pF |
| Small-Signal Current Gain (IC = 50 mAdc, VCE = 10 Vdc, f = 20 MHz) | | h _{fe} | 2.5 | 25 | |

(1) Pulse Test: Pulse Width ≤ 30 µs, Duty Cycle ≤ 2.0%.

| Rating | Symbol | MPS6516 | MPS6517 | Unit |
|---|-----------------------------------|------------|---------|----------------|
| Collector-Emitter Voltage | VCEO | 60 | 80 | Vdc |
| Collector-Base Voltage | VCBO | 60 | 80 | Vdc |
| Emitter-Base Voltage | VEBO | 5 | .0 | Vdc |
| Collector Current — Continuous | lc | 500 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.5 20 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 55 to | + 150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|-----|------|
| Thermal Resistance, Junction to Case | Rac | 50 | °C/W |
| Thermal Resistance, Junction to Ambient | RAIA | 125 | °C/W |

MPS6716 MPS6717

CASE 29-03, STYLE 1 TO-92 (TO-226 AE)

AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MPSW05 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------|----------------------|----------|------------|------|
| OFF CHARACTERISTICS | | | | • | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, B = 0) | MPS6716 MPS6717 | V(BR)CEO | 60 80 | = | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | MPS6716 MPS6717 | V(BR)CBO | 60 80 | = | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 40 Vdc, IE = 0) (VCB = 60 Vdc, IE = 0) | MPS6716 MPS6717 | ІСВО | _ | 0.1 0.1 | μAdc |
| Emitter Cutoff Current (VEB = 5.0 Vdc, IC = 0) | | lEBO | | 10 | μAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain (IC = 50 mAdc, VCE = 1.0 Vdc) (IC = 250 mAdc, VCE = 1.0 Vdc) | | ptE | 80 50 | 250 | - |
| Collector-Emitter Saturation Voltage (IC = 250 mAdc, IB = 10 mAdc) | | V _{CE(sat)} | _ | 0.5 | Vdc |
| Base-Emitter On Voltage (IC = 250 mAdc, VCE = 1.0 Vdc) | | VBE(on) | _ | 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Collector-Base Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | | C _{cb} | _ | 30 | pF |
| Small-Signal Current Gain (IC = 200 mAdc, VCE = 5.0 Vdc, f = 20 MHz) | | h _{fe} | 2.5 | 25 | _ |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MPS6724 MPS6725

CASE 29-03, STYLE 1 (TO-226 AE)

DARLINGTON TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | MPS6724 | MPS6725 | Unit |
|---|----------------------|------------|---------|----------------|
| Collector-Emitter Voltage | VCES | 40 | 50 | Vdc |
| Collector-Base Voltage | VCBO | 50 | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 1 | 2 | Vdc |
| Collector Current — Continuous | lc | 1000 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.5 20 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | - 55 to | + 150 | ొ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|-----|------|
| Thermal Resistance, Junction to Case | Rejc | 50 | Ş |
| Thermal Resistance, Junction to Ambient | R _{BJA} | 125 | °C/W |

Refer to 2N6426 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------|---------------------|-----------------|------------|------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | MPS6724 MPS6725 | V(BR)CES | 40 50 | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 1.0 μ Adc, IE = 0) | MPS6724 MPS6725 | V(BR)CBO | 50 60 | _ | Vdc Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | | V(BR)EBO | 12 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 30 Vdc, I_E = 0) (V _{CB} = 40 Vdc, I_E = 0) | MPS6724 MPS6725 | Ісво | _ | 100 100 | nAdc |
| Emitter Cutoff Current (VEB = 10 Vdc, I _C = 0) | | IEBO | _ | 100 | nAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain (I _C = 200 mAdc, V _{CE} = 5.0 Vdc) (I _C = 1000 mAdc, V _{CE} = 5.0 Vdc) | | hFE | 25,000 4,000 | 40,000 | _ |
| Collector-Emitter Saturation Voltage (IC = 1000 mAdc, IB = 2.0 mAdc) | | VCE(sat) | 1 | 1.5 | Vdc |
| Base-Emitter On Voltage (IC = 1000 mAdc, VCE = 5.0 Vdc) | | V _{BE(on)} | - | 2.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 200 mAdc, VCE = 5.0 Vdc, f = 100 MHz) | | fT | 100 | 1000 | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | | C _{cb} | _ | 10 | pF |

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage MPS6726 MPS6727 | VCEO | 30 40 | Vdc |
| Collector-Base Voltage MPS6726 MPS6727 | VCBO | 40 50 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | ¹c | 1.0 | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.5 20 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|-----|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 50 | °C/W |
| Thermal Resistance, Junction to Ambient | RAIA | 125 | °C/W |

MPS6726 MPS6727

CASE 29-03, STYLE 1 TO-92 (TO-226 AE)

AMPLIFIER TRANSISTOR

PNP SILICON

Refer to MPSW51 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------|-----------------|----------|------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 10 mAdc, IB = 0) | MPS6726 MPS6727 | V(BR)CEO | 30 40 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0) | MPS6726 MPS6727 | V(BR)CBO | 40 50 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 40 Vdc, IE = 0) (VCB = 50 Vdc, IE = 0) | MPS6726 MPS6727 | Ісво | _ | 0.1 0.1 | μAdc |
| Emitter Cutoff Current (VEB = 5.0 Vdc, IC = 0) | | IEBO | _ | 0.1 | μAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain (IC = 100 mAdc, V _{CE} = 1.0 Vdc) (IC = 1000 mAdc, V _{CE} = 1.0 Vdc) | , | hFE | 60 50 | 250 | _ |
| Collector-Emitter Saturation Voltage (IC = 1000 mAdc, IB = 100 mAdc) | | VCE(sat) | _ | 0.5 | Vdc |
| Base-Emitter On Voltage (IC = 1000 mAdc, VCE = 1.0 Vdc) | | VBE(on) | _ | 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | • | | • | |
| Collector-Base Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | | C _{cb} | _ | 30 | pF |
| Small-Signal Current Gain (IC = 50 mAdc, VCE = 10 Vdc, f = 20 MHz) | | h _{fe} | 2.5 | 25 | _ |

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

MPS6728 MPS6729

CASE 29-03, STYLE 1 TO-92 (TO-226 AE)

AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | MPS6728 | MPS6729 | Unit |
|---|----------------------|------------|---------------|----------------|
| Collector-Emitter Voltage | VCEO | 60 | 80 | Vdc |
| Collector-Base Voltage | VCBO | 60 | 80 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc |
| Collector Current — Continuous | lc | 500 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.5 20 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | - 55 to | - 55 to + 150 | |

THERMAL CHARACTERISTICS

| TILLIMAL OF ALACTEMETICS | | | |
|---|--------|-----|------|
| Characteristic | Symbol | Max | Unit |
| Thermal Resistance, Junction to Case | ReJC | 50 | °C/W |
| Thermal Resistance, Junction to Ambient | ReJA | 125 | °C/W |

Refer to MPSW55 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------|---------------------|----------|------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (I _C = 1.0 mAdc, I _B = 0) | MPS6728 MPS6729 | V(BR)CEO | 60 80 | = | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μ Adc, I _E = 0) | MPS6728 MPS6729 | V(BR)CBO | 60 80 | = | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VEB = 5.0 Vdc, IC = 0) | | IEBO | _ | 10 | μAdc |
| Emitter Cutoff Current (VCB = 40 Vdc, IE = 0) (VCB = 60 Vdc, IE = 0) | MPS6728 MPS6729 | ІСВО | | 0.1 0.1 | μAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain {I _C = 50 mAdc, V _{CE} = 1.0 Vdc} {I _C = 250 mAdc, V _{CE} = 1.0 Vdc} | | hFE | 80 50 | 250 | = |
| Collector-Emitter Saturation Voltage (IC = 250 mAdc, IB = 10 mAdc) | | VCE(sat) | | 0.5 | Vdc |
| Base-Emitter On Voltage (IC = 250 mAdc, VCE = 1.0 Vdc) | | V _{BE(on)} | - | 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Collector-Base Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | | C _{cb} | | 30 | pF |
| Small-Signal Current Gain (IC = 200 mAdc, VCE = 5.0 Vdc, f = 20 MHz) | | h _{fe} | 2.5 | 25 | |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| MAXIMON NATINGS | | | | | | | | |
|--|-----------------------------------|-----------|--------------|---------|----------------|--|--|------|
| Rating | Symbol | MPS6735 | MPS6734 | MPS6733 | Unit | | | |
| Collector-Emitter Voltage | VCEO | 300 | 250 | 200 | Vdc | | | |
| Collector-Base Voltage | V _{CBO} | 300 | 250 | 200 | Vdc | | | |
| Emitter-Base Voltage | VEBO | | 6.0 | | | | | |
| Collector Current — Continuous | lc | 300 | | | 300 | | | mAdc |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | | 1.0 8.0 | | Watt mW/°C | | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.5 20 | | | Watts mW/°C | | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | | - 55 to + 15 | 0 | °C | | | |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|-----|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 50 | °C/W |
| Thermal Resistance, Junction to Ambient | RAIA | 125 | °C/W |

MPS6733 MPS6734 MPS6735

CASE 29-03, STYLE 1 TO-92 (TO-226 AE)

HIGH VOLTAGE TRANSISTOR

NPN SILICON

Refer to MPSW42 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|-------------------------------|---------------------|-------------------|-------------------|----------|
| OFF CHARACTERISTICS | <u> </u> | • | | | · |
| Collector-Emitter Breakdown Voltage(1) (I _C = 10 mAdc, I _B = 0) | MPS6735 MPS6734 MPS6733 | V(BR)CEO | 300 250 200 | = | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μAdc, I _E = 0) | MPS6735 MPS6734 MPS6733 | V(BR)CBO | 300 250 200 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 6.0 | - | Vdc |
| Collector Cutoff Current (V _{CB} = 260 Vdc, I _E = 0) (V _{CB} = 200 Vdc, I _E = 0) (V _{CB} = 160 Vdc, I _E = 0) | MPS6735 MPS6734 MPS6733 | СВО | = | 0.1 0.1 0.1 | μAdc |
| Emitter Cutoff Current (VEB = 6.0 Vdc, IC = 0) | | (EBO | | 0.1 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc) | | pŁE | 25 40 | _ 200 | _ |
| Collector-Emitter Saturation Voltage (IC = 20 mAdc, IB = 2.0 mAdc) | | VCE(sat) | _ | 2.0 | Vdc |
| Base-Emitter On Voltage (IC = 20 mAdc, VCE = 10 Vdc) | | V _{BE(on)} | _ | 2.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | <u> </u> |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 20 MHz) | | fτ | 50 | 200 | MHz |
| Collector-Base Capacitance {VCB = 20 Vdc, I _E = 0, f = 1.0 MHz} | | C _{cb} | _ | 3.0 | pF |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MPS8093

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | VCBO | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc lc | 200 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 60°C | PD | 450 | mW |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------|------|
| Thermal Resistance, Junction to Case | ReJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | Reja | 200 | •cw |

Refer to 2N4402 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|---------------------|-----|------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 10 mAdc) | V(BR)CEO | 40 | | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 µAdc) | V(BR)CBO | 40 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 µAdc) | V(BR)EBO | 5.0 | | Vdc |
| Collector Cutoff Current (V _{CB} = 20 V) | ІСВО | - | 100 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 V) | IEBO | _ | 100 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 50 mAdc, VCE = 2.0 Vdc) | hFE | 100 | 300 | _ |
| Collector-Emitter Saturation Voltage (IC = 50 mAdc, IB = 5.0 mAdc) | VCE(sat) | _ | 0.25 | Vdc |
| Base-Emitter On Voltage (IC = 50 mAdc, VCE = 2.0 V) | V _{BE(on)} | 0.6 | 1.0 | Vdc |

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | Vdc |
| Collector Current — Continuous | lc lc | 200 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | Reia(1) | 200 | °C/W |

MPS8097

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MPSA18 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|---------------------|------|----------|--------------|
| OFF CHARACTERISTICS | | | | .• |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, Ig = 0) | V(BR)CEO | 40 | _ | Vdc |
| Collector Cutoff Current (VCB = 40 Vdc, IE = 0) (VCB = 60 Vdc, IE = 0) | ſСВО | _ | 30 10 | nAdc µAdc |
| Emitter Cutoff Current (VBE = 6.0 Vdc, IC = 0) | ^I EBO | | 20 | nAdc |
| ON CHARACTERISTICS(2) | | | | • |
| DC Current Gain (IC = 100 µAdc, V _{CE} = 5.0 Vdc) | ptE | 250 | 700 | _ |
| Base-Emitter On Voltage (IC = 100 µAdc, VCE = 5.0 Vdc) | V _{BE(on)} | 0.45 | 0.65 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | • |
| Output Capacitance (VCB = 5.0 Vdc, I _E = 0, f = 1.0 MHz) | Cobo | 1.0 | 4.0 | pF |
| Emitter-Base Capacitance (VBE = 0.5 Vdc, IC = 0, f = 1.0 MHz) | C _{eb} | _ | 10 | pF |
| Small-Signal Current Gain (IC = 100 µAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | h _{fe} | 250 | 800 | _ |
| Noise Figure ($I_C = 100 \mu\text{Adc}$, $V_{CE} = 5.0 \text{Vdc}$, $R_S = \text{kOhms}$, $f = 10 \text{Hz}$ to 15.7 KHz) | NF | _ | 2.0 | dB |
| Equivalent Short Circuit Noise Voltage (IC = 100 μAdc, VCE = 5.0 Vdc, RS = 10 kOhms, f = 100 Hz, Bw = 1.0 Hz) | e _n | _ | 32 | nV/√Hz |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board. (2) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

NPN MPS8098 MPS8099

PNP MPS8598 MPS8599

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

MAXIMUM RATINGS

| 110001110111111111111111111111111111111 | | | | |
|---|-----------------------------------|--------------------|--------------------|----------------|
| Rating | Symbol | MPS8098 MPS8598 | | Unit |
| Collector-Emitter Voltage | VCEO | 60 | 80 | Vdc |
| Collector-Base Voltage | VCBO | 60 | 80 | Vdc |
| | | | MPS8598 MPS8599 | |
| Emitter-Base Voltage | VEBO | 6.0 | 5.0 | Vdc |
| Collector Current — Continuous | lc | 500 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | | mW mW/℃ |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12.0 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------|------|
| Thermal Resistance, Junction to Case | ReJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | RAJA | 200 | °CW |

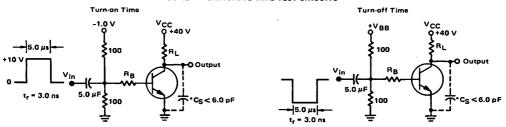
| CI COTDICAL | CHARACTERISTICS (TA | Sec unlace | othonuico no | f hot |
|-------------|---------------------|----------------|--------------|-------|
| | | | | |

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------------------------|---------------------|------------------|---------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | MPS8098, MPS8598 MPS8099, MPS8599 | V(BR)CEO | 60 80 | = | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μAdc, IE = 0) | MPS8098, MPS8598 MPS8099, MPS8599 | V(BR)CBO | 60 80 | = | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | MPS8098, MPS8099 MPS8598, MPS8599 | V(BR)EBO | 6.0 5.0 | | Vdc |
| Collector Cutoff Current (VCE = 60 Vdc, IB = 0) | | ICEO | | 0.1 | μAdc |
| Collector Cutoff Current (VCB = 60 Vdc, IE = 0) (VCB = 80 Vdc, IE = 0) | MPS8098, MPS8598 MPS8099, MPS8599 | СВО | _ | 0.1 0.1 | μAdc |
| Emitter Cutoff Current (VEB = 6.0 Vdc, IC = 0) (VEB = 4.0 Vdc, IC = 0) | MPS8098, MPS8099 MPS8598, MPS8599 | IEBO | | 0.1 0.1 | μAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain (IC = 1.0 mAdc, V _{CE} = 5.0 Vdc) (IC = 10 mAdc, V _{CE} = 5.0 Vdc) (I(C = 100 mAdc, V _{CE} = 5.0 Vdc) | | hFE | 100 100 75 | 300 — — | _ |
| Collector-Emitter Saturation Voltage (IC = 100 mAc | | VCE(sat) | _ | 0.4 0.3 | Vdc |
| Base-Emitter On Voltage {I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc} {I _C = 10 mAdc, V _{CE} = 5.0 Vdc} | MPS8098, MPS8598 MPS8099, MPS8599 | V _{BE(on)} | 0.5 0.6 | 0.7 0.8 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 5.0 Vdc, f = 100 MHz) | | fτ | 150 | | MHz |
| Output Capacitance (VCB = 5.0 Vdc, I _E = 0, f = 1.0 MHz) | MPS8098, MPS8099 MPS8598, MPS8599 | C _{obo} | _ | 6.0 8.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | MPS8098, MPS8099 MPS8598, MPS8599 | Cibo | _ | 25 30 | pF |

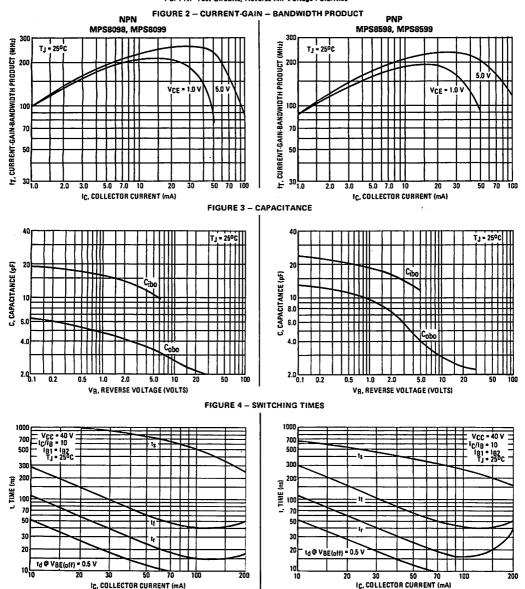
(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle = 2.0%.

NPN MPS8098, MPS8099, PNP MPS8598, MPS8599

FIGURE 1 - SWITCHING TIME TEST CIRCUITS



*Total Shunt Capacitance of Test Jig and Connectors For PNP Test Circuits, Reverse All Voltage Polarities



NPN MPS8098, MPS8099, PNP MPS8598, MPS8599

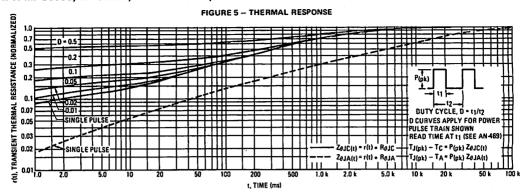


FIGURE 6—ACTIVE REGION, SAFE OPERATING AREA MPS 8098, MPS 8099

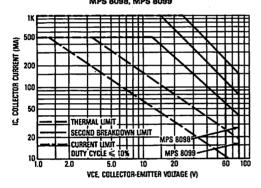
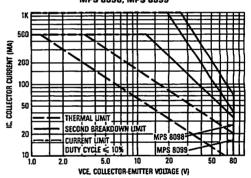
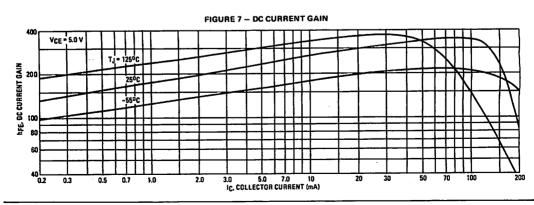


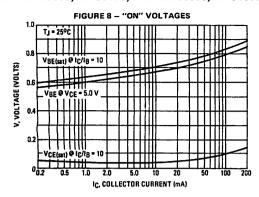
FIGURE 6—ACTIVE REGION, SAFE OPERATING AREA MPS 8598, MPS 8599

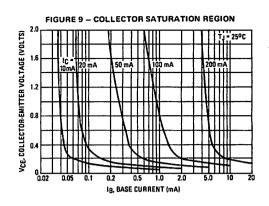


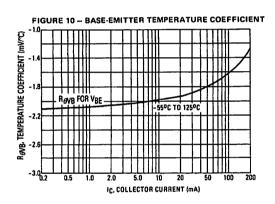
MPS8098, MPS8099



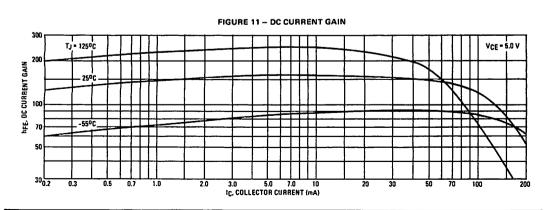
NPN MPS8098, MPS8099, PNP MPS8598, MPS8599

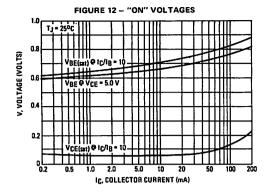


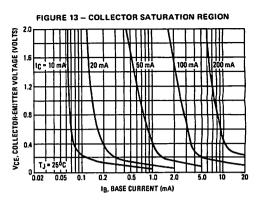


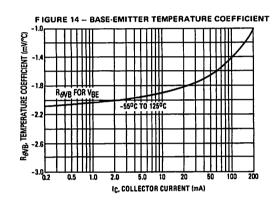


MPS8598, MPS8599









| Rating | Symbol | | MPSA66 MPSA56 | Unit |
|---|----------------------|------------|------------------|----------------|
| Collector-Emitter Voltage | VCEO | 60 | 80 | Vdc |
| Collector-Base Voltage | VCBO | 60 | 80 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | | Vdc |
| Collector Current — Continuous | lc | 500 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | - 55 to | + 150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|---------|------|------|
| Thermal Resistance, Junction to Case | RøJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | Raja(1) | 200 | °C/W |

⁽¹⁾ R_{EJA} is measured with the device soldered into a typical printed circuit board.

NPN MPSA05 MPSA06

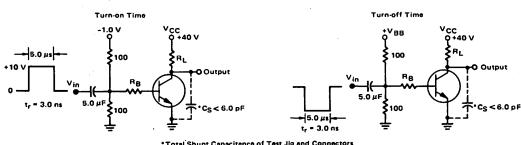
PNP MPSA55 MPSA56

CASE 29-02, STYLE 1 TO-92 (TO-226AA) **AMPLIFIER TRANSISTOR**

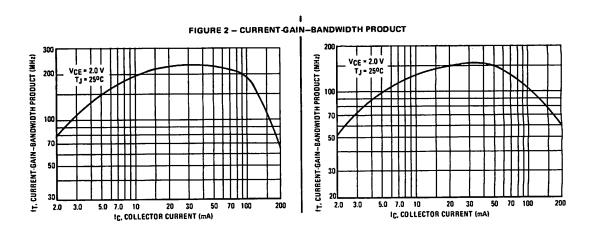
| Characteristic | | Symbol | Min | Max | Unit |
|---|----------------------------------|---------------------|----------|-------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | MPSA05, MPSA55 MPSA06, MPSA56 | V(BR)CEO | 60 80 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 4.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 60 Vdc, IB = 0) | | ICEO | _ | 0.1 | μAdc |
| Collector Cutoff Current (VCB = 60 Vdc, IE = 0) (VCB = 80 Vdc, IE = 0) | MPSA05, MPSA55 MPSA06, MPSA56 | ІСВО | _ | 0.1 0.1 | μAdc |
| ON CHARACTERISTICS | | | | 1 | · |
| DC Current Gain (IC = 10 mAdc, V _{CE} = 1.0 Vdc) (IC = 100 mAdc, V _{CE} = 1.0 Vdc) | | hFE | 50 50 | | - |
| Collector-Emitter Saturation Voltage (IC = 100 mAdc, Ig = 10 mAdc) | | VCE(sat) | _ | 0.25 | Vdc |
| Base-Emitter On Voltage (IC = 100 mAdc, VCE = 1.0 Vdc) | | V _{BE(on)} | _ | 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | · |
| Current-Gain — Bandwidth Product(2) (I _C = 10 mA, V _{CE} = 2.0 V, f = 100 MHz) | MPSA05 MPSA06 | fŢ | 100 | _ | MHz |
| $(I_{C} = 100 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc}, f = 100 \text{ MHz})$ | MPSA55 MPSA56 | | 50 | - | |

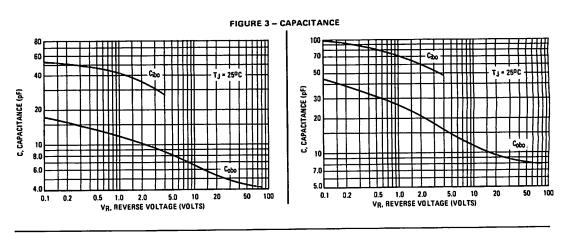
Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
 f⊤ is defined as the frequency at which |hfe| extrapolates to unity.

FIGURE 1 - SWITCHING TIME TEST CIRCUITS

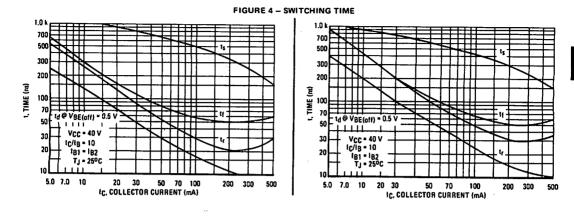


*Total Shunt Capacitance of Test Jig and Connectors For PNP Test Circuits, Reverse All Voltage Polarities





NPN MPSA05, MPSA06, PNP MPSA55, MPSA56



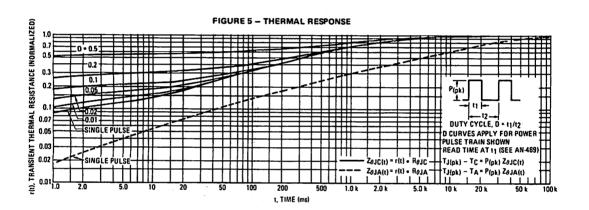
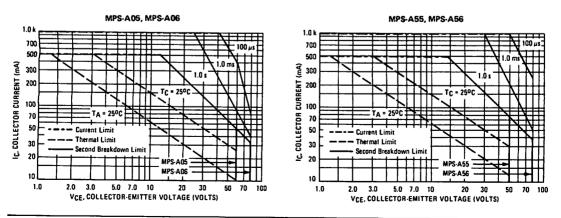


FIGURE 6 - ACTIVE - REGION SAFE OPERATING AREA



NPN MPS-A05, MPS-A06

FIGURE 7 - DC CURRENT GAIN

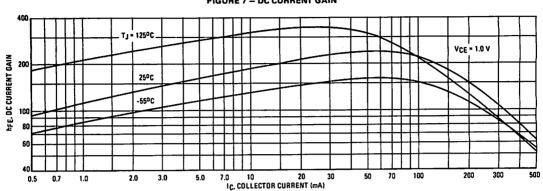
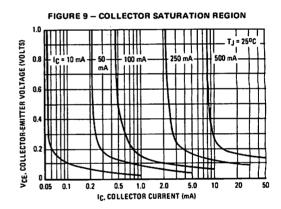
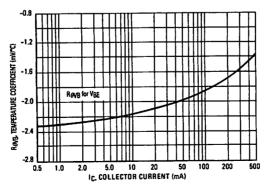


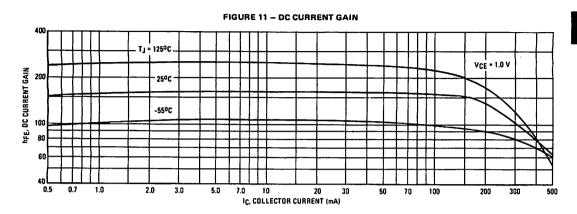
FIGURE 8 - "ON" VOLTAGES

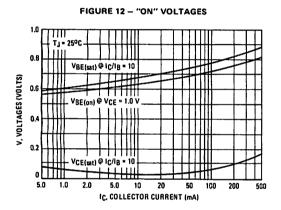


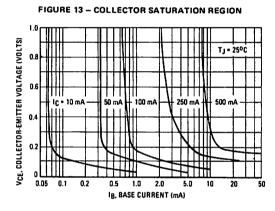


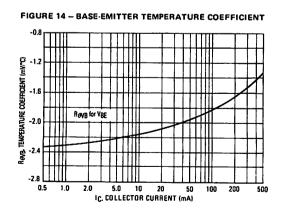


PNP MPS-A55, MPS-A56









MPSA09

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MAXIMON NATINGO | | | |
|---|-----------------------------------|-------------|---------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 50 | Vdc |
| Collector-Base Voltage | VCBO | 50 | Vdc |
| Collector Current — Continuous | lc | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | ୯ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 200 | •c/w |
| Thermal Resistance, Junction to Case | Rajc | 83.3 | •c/w |

Refer to MPSA18 for graphs.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|---------------------|----------|-----|-----|--------------|
| OFF CHARACTERISTICS | | | · | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, Ig = 0) | V(BR)CEO | 50 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.1 mAdc, IE = 0) | V(BR)CBO | 50 | | _ | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0) | ICBO | _ | _ | 100 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | IEBO | _ | _ | 100 | nAdc |
| ON CHARACTERISTICS | | | | | , |
| DC Current Gain (IC = 0.1 mAdc, VCE = 5.0 Vdc) | pŁE | 100 | | 600 | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | VCE(sat) | | | 0.9 | Vdc |
| Base-Emitter On Voltage (IC = 1.0 mAdc, VCE = 5.0 Vdc) | V _{BE(on)} | _ | | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 0.5 mAdc, VCE = 5.0 Vdc, f = 20 MHz) | fτ | 30 | 80 | _ | MHz |
| Output Capacitance (VCB = 5.0 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | _ | _ | 5.0 | pF |
| Noise Figure (IC = 0.1 mAdc, VCE = 5.0 Vdc, RS = 0.8 k ohms, f = 1.0 kHz) | NF | <u> </u> | 1.4 | | dB |

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|---------------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | lc | 100 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------|------|
| Thermal Resistance, Junction to Case | ReJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | RAJA | 200 | °C/W |

MPSA10

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MPS3903 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|-----|--------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) | V(BR)CEO | 40 | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 µAdc, I _C = 0) | V(BR)EBO | 4.0 | - | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0) | l _{CBO} | _ | 100 | nAdc |
| ON CHARACTERISTICS | <u></u> | | ' | L |
| DC Current Gain (IC = 5.0 mAdc, VCE = 10 Vdc) | hte | 40 | 400 | _ |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 5.0 mAdc, VCE = 10 Vdc, f = 100 MHz) | fT | 125 | - | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | _ | 4.0 | pF |

MPSA12

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

DARLINGTON TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|------------|
| Collector-Emitter Voltage | VCES | 20 | Vdc |
| Emitter-Base Voltage | VEBO | 10 | Vdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/℃ |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|-----|------|
| Thermal Resistance, Junction to Ambient | ReJA | 200 | °C/W |

Refer to 2N6426 for graphs.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|------------------|--------|-----|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 100 µAdc, I _B = 0) | V(BR)CES | 20 | _ | | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) | ІСВО | _ | | 100 | nAdc |
| Collector Cutoff Current (V _{CE} = 15 Vdc, V _{BE} = 0) | ICES | _ | _ | 100 | nAdc |
| Emitter Cutoff Current (VEB = 10 Vdc, IC = 0) | ^Į EBO | _ | _ | 100 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) | hFE | 20,000 | - | _ | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 0.01 mAdc) | VCE(sat) | | _ | 1.0 | Vdc |
| Base-Emitter On Voltage (IC = 10 mAdc, VCE = 5.0 Vdc) | VBE | _ | _ | 1.4 | Vdc |

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|--------------|----------------|
| Collector-Emitter Voltage | VCES | 30 | Vdc |
| Collector-Base Voltage | V _{CBO} | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 10 | Vdc |
| Collector Current — Continuous | lc | 500 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Case | Rajc | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 200 | °C/W |

MPSA13 MPSA14

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

DARLINGTON TRANSISTOR

NPN SILICON

Refer to 2N6426 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|------------------|----------------------|------------------|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 100 \(mu\)Adc, Ig = 0) | | V(BR)CES | 30 | | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, I _E = 0) | | ІСВО | _ | 100 | nAdo |
| Emitter Cutoff Current (VBE = 10 Vdc, IC = 0) | | !EBO | - | 100 | nAdd |
| ON CHARACTERISTICS(1) | | | | | L |
| DC Current Gain (IC = 10 mAdc, V _{CE} = 5.0 Vdc) | MPSA13 MPSA14 | pkE | 5000 10,000 | = | _ |
| (I _C = 100 mAdc, V _{CE} = 5.0 Vdc) | MPSA13 MPSA14 | | 10,000 20,000 | _ | |
| Collector-Emitter Saturation Voltage (IC = 100 mAdc, Ig = 0.1 mAdc) | | V _{CE(sat)} | - | 1.5 | Vdc |
| Base-Emitter On Voltage (IC = 100 mAdc, VCE = 5.0 Vdc) | | VBE | | 2.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product(2) (IC = 10 mAdc, V _{CE} = 5.0 Vdc, f = 100 MHz) | | fτ | 125 | | MHz |

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%. (2) fT = |hfe| • ftest-

MPSA16 MPSA17

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

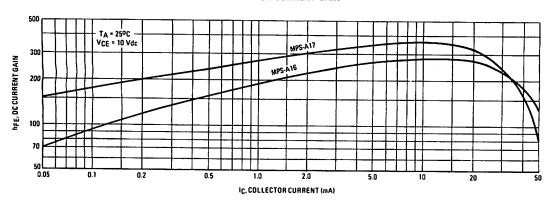
| Rating | Symbol | MPS-A16 | MPS-A17 | Unit |
|--|-----------------------------------|------------|-------------|---------------|
| Collector-Emitter Voltage | VCEO | 4 | 0 | Vdc |
| Emitter-Base Voltage | VEBO | 12 | 15 | Vdc |
| Collector Current — Continuous | lc | 100 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | – 55 to | -55 to +150 | |

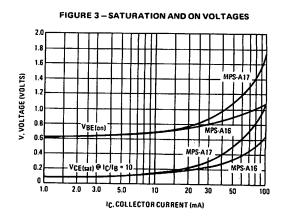
THERMAL CHARACTERISTICS

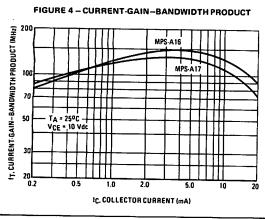
| Characteristic | Symbol | Max | Unit |
|---|--------|------|------|
| Thermal Resistance, Junction to Ambient | ReJA | 200 | °C/W |
| Thermal Resistance, Junction to Case | ReJC | 83.3 | °C/W |

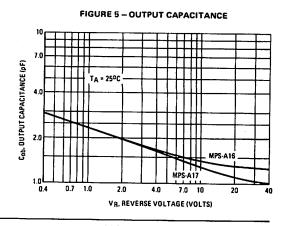
| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------|------------------|-----------|-------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, Ig = 0) | | V(BR)CEO | 40 | | Vdc |
| Emitter-Base Breakdown Voltage (IE = 0.1 mAdc, IC = 0) | MPS-A16 MPS-A17 | V(BR)EBO | 12 15 | | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0) | | ICBO | | 100 | nAdc |
| Emitter Cutoff Current (VBE = 10 Vdc, IC = 0) | | IEBO | | 100 | nAdc |
| ON CHARACTERISTICS | | | | | Τ |
| DC Current Gain (IC = 5.0 mAdc, VCE = 10 Vdc) | | hFE | 200 | 600 | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | | VCE(sat) | | 0.25 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | T |
| Current-Gain — Bandwidth Product (IC = 5.0 mAdc, VCE = 10 Vdc, f = 100 MHz) | MPS-A16 MPS-A17 | fr | 100 80 | = | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | | C _{obo} | _ | 4.0 | pF |

FIGURE 1 - DC CURRENT GAIN









MPSA18

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

LOW NOISE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 45 | Vdc |
| Collector-Base Voltage | VCBO | 45 | Vdc |
| Emitter-Base Voltage | VEBO | 6.5 | Vdc |
| Collector Current — Continuous | lc | 200 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/℃ |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

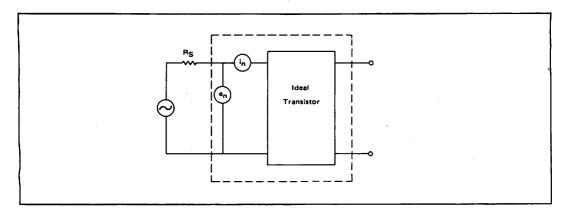
| Characteristic | Symbol | Max | Unit |
|---|---------|------|------|
| Thermal Resistance, Junction to Case | RøJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | ROJA(1) | 200 | °C/W |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|----------------------|--------------------------|----------------------------|---------------------|--------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, Ig = 0) | V(BR)CEO | 45 | - | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 45 | - | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 6.5 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, lg = 0) | СВО | _ | 1.0 | 50 | nAdc |
| ON CHARACTERISTICS(2) | | | | | |
| DC Current Gain (I _C = 10 μAdc, V _{CE} = 5.0 Vdc) (I _C = 100 μAdc, V _{CE} = 5.0 Vdc) (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc) (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) | hFE | 400 500 500 500 | 580 850 1100 1150 | _ _ _ 1500 | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 0.5 mAdc) (Ic = 50 mAdc, Ig = 5.0 mAdc) | V _{CE(sat)} | _ | 0.08 | 0.2 0.3 | Vdc |
| Base-Emitter On Voltage (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc) | V _{BE(on)} | _ | 0.6 | 0.7 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc, f = 100 MHz) | fτ | 100 | 160 | | MHz |
| Collector-Base Capacitance (VCB = 5.0 Vdc, IE = 0, f = 1.0 MHz) | C _{cb} | | 1.7 | 3.0 | pF |
| Emitter-Base Capacitance (VFB = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | C _{eb} | _ | 5.6 | 6.5 | pF |
| Noise Figure (IC = 100 μAdc, VCE = 5.0 Vdc, RS = 10 kΩ, f = 10 Hz to 15.7 kHz) (IC = 100 μAdc, VCE = 5.0 Vdc, RS = 1.0 kΩ, f = 100 Hz) | NF | | 0.5 4.0 | 1.5 | dB |
| Equivalent Short Circuit Noise Voltage (I _C = 100 μAdc, V _{CE} = 5.0 Vdc, R _S = 1.0 kΩ, f = 100 Hz) | VT | _ | 6.5 | | nV/√Hz |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board. (2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

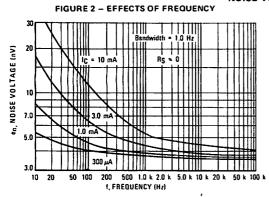
FIGURE 1 - TRANSISTOR NOISE MODEL

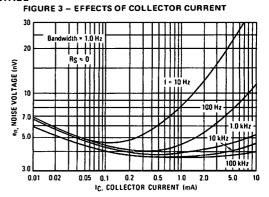


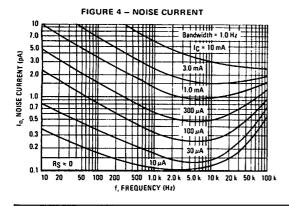
NOISE CHARACTERISTICS

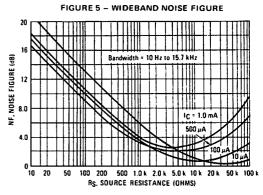
(VCE = 5.0 Vdc, TA = 25°C)

NOISE VOLTAGE

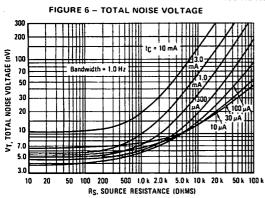








100 Hz NOISE DATA



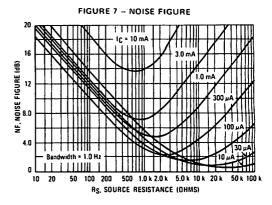


FIGURE 8 - DC CURRENT GAIN

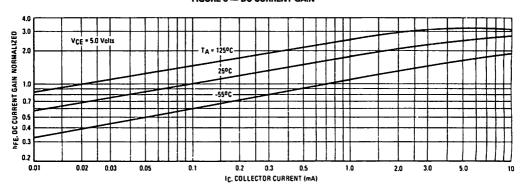


FIGURE 9 - "ON" VOLTAGES

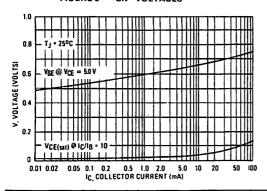


FIGURE 10 - TEMPERATURE COEFFICIENTS

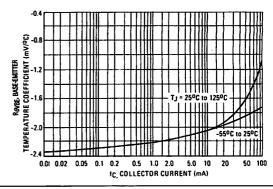


FIGURE 11 - CAPACITANCE

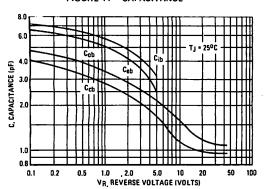
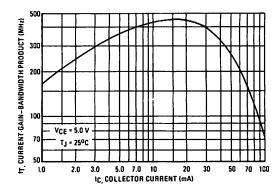


FIGURE 12 - CURRENT-GAIN-BANDWIDTH PRODUCT



MPSA20

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|---------------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | VCBO | 4.0 | Vdc |
| Collector Current — Continuous | lc | 100 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|----------------------|------|------|
| Thermal Resistance, Junction to Case | ReJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 200 | °C/W |

Refer to MPS3903 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|------------------|-----|------|------|
| OFF CHARACTERISTICS | - | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 40 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 µAdc, IC = 0) | V(BR)EBO | 4.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0) | СВО | _ | 100 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain(2) (I _C = 5.0 mAdc, V _{CE} = 10 Vdc) | ptE | 40 | 400 | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | VCE(sat) | _ | 0.25 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product(2) (I _C = 5.0 mAdc, V _{CE} = 10 Vdc, f = 100 MHz | fτ | 125 | _ | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | | 4.0 | pF |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board. (2) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

| WANIMOW RATINGS | | | | | |
|--|-----------------------------------|------------|-------------|---------|-------------|
| Rating | Symbol | MPS-A25 | MPS-A26 | MPS-A27 | Unit |
| Collector-Emitter Voltage | VCES | 40 | 50 | 60 | Vdc |
| Emitter-Base Voltage | VEBO | | 10 | | |
| Collector Current — Continuous | lc | | 500 | | |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 625 5.0 | | | mW mW/°C |
| Operating and Storage Junction | T _J , T _{stg} | _ | -55 to +150 | | |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|-----|------|
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 200 | °C/W |

MPSA25 MPSA26 MPSA27

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

DARLINGTON TRANSISTOR

NPN SILICON

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|----------------------------|-----------------|------------------|-----|-------------------|------|
| OFF CHARACTERISTICS | | | | | · | |
| Collector-Emitter Breakdown Voltage (IC = 100 μ Adc, VBE = 0) | MPSA25 MPSA26 MPSA27 | V(BR)CES | 40 50 60 | | = | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0) | MPSA25 MPSA26 MPSA27 | V(BR)CBO | 40 50 60 | | <u>-</u> | Vdc |
| Collector Cutoff Current (V _{CB} = 30 V, I _E = 0) (V _{CB} = 40 V, I _E = 0) (V _{CB} = 50 V, I _E = 0) | MPSA25 MPSA26 MPSA27 | СВО | | | 100 100 100 | nAdc |
| Collector Cutoff Current (VCE = 30 V, VBE = 0) (VCE = 40 V, VBE = 0) (VCE = 50 V, VBE = 0) | MPSA25 MPSA26 MPSA27 | ICES | _ _ _ | | 500 500 500 | nAdc |
| Emitter Cutoff Current (VBE = 10 Vdc) | | IEBO | _ | - | 100 | nAdc |
| ON CHARACTERISTICS(1) | | - - | | - | | |
| DC Current Gain (IC = 10 mA, V _{CE} = 5.0 V) (IC = 100 mA, V _{CE} = 5.0 V) | | hFE | 10,000 10,000 | _ | = | _ |
| Collector-Emitter Saturation Voltage (I _C = 100 mA, I _B = 0.1 mAdc) | | VCE(sat) | _ | _ | 1.5 | Vdc |
| Base-Emitter On Voltage (IC = 100 mA, VCE = 5.0 Vdc) | | VBE(on) | _ | - | 2.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Small Signal Current Gain (IC = 10 mA, VCE = 5.0 V, f = 100 MHz) | | h _{fe} | 1.25 | 2.4 | - | _ |

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

FIGURE 1 - DC CURRENT GAIN

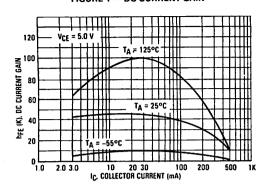


FIGURE 2 - "ON" VOLTAGES

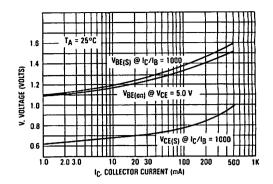


FIGURE 3 — COLLECTOR SATURATION REGION

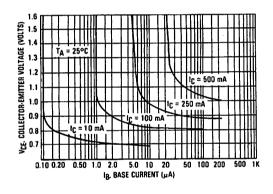


FIGURE 4 — HIGH FREQUENCY CURRENT GAIN

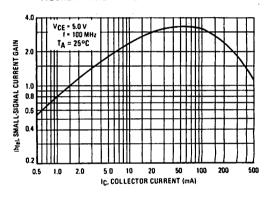
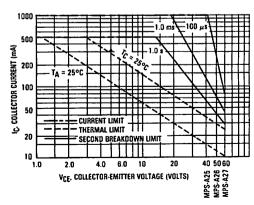


FIGURE 5 - ACTIVE REGION SAFE OPERATING AREA



| Rating | Symbol | MPSA28 | MPSA29 | Unit |
|---|----------------------|-------------|--------|----------------|
| Collector-Emitter Voltage | VCES | 80 | 100 | Vdc |
| Collector-Base Voltage | V _{CBO} | 80 | 100 | Vdc |
| Emitter-Base Voltage | VEBO | 12 | | Vdc |
| Collector Current — Continuous | lc | 500 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | RAJA | 200 | °C/W |

MPSA28 MPSA29

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

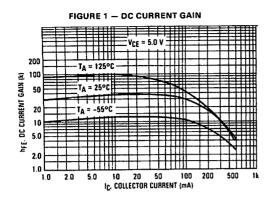
DARLINGTON TRANSISTOR

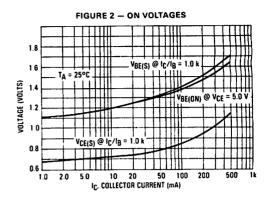
NPN SILICON

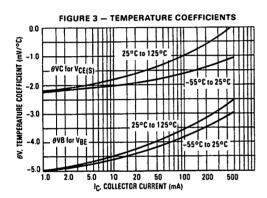
| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|--------------------------|---------------------|------------------|------------|------------|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 100 μAdc, V _{BE} = 0) | MPSA28 MPSA29 | V(BR)CES | 80 100 | = | = | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0) | MPSA28 MPSA29 | V(BR)CBO | 80 100 | - | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | Both Types | V(BR)EBO | 12 | - | _ | Vdc |
| Collector Cutoff Current (VCB = 60 Vdc, IE = 0) (VCB = 80 Vdc, IE = 0) | MPSA28 MPSA29 | Ісво | _ | = | 100 100 | nAdc |
| Collector Cutoff Current (VCE = 60 Vdc, VBE = 0) (VCE = 80 Vdc, VBE = 0) | MPSA28 MPSA29 | ICES | _ | _ | 500 500 | nAdc |
| Emitter Cutoff Current (VBE = 10 Vdc, IC = 0) | Both Types | ^I EBO | _ | - | 100 | nAdc |
| ON CHARACTERISTICS(1) | | • | | | | • |
| DC Current Gain (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) (I _C = 100 mAdc, V _{CE} = 5.0 Vdc) | Both Types Both Types | hFE | 10,000 10,000 | _ | _ | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 0.01 mAdc) (I _C = 100 mAdc, I _B = 0.1 mAdc) | Both Types Both Types | VCE(sat) | - | 0.7 0.8 | 1.2 1.5 | Vdc |
| Base-Emitter On Voltage (IC = 100 mAdc, VCE = 5.0 Vdc) | Both Types | V _{BE(on)} | _ | 1.4 | 2.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product(2) (I _C = 10 mAdc, V _{CE} = 5.0 Vdc, f = 100 MHz) | Both Types | fτ | 125 | 200 | - | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | Both Types | C _{obo} | | 5.0 | 8.0 | pF |

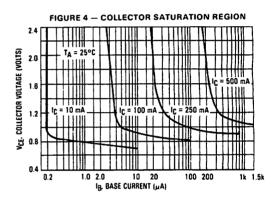
⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

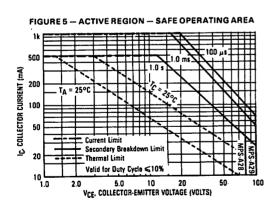
⁽²⁾ $f_T = h_{fe} \cdot f_{test}$.

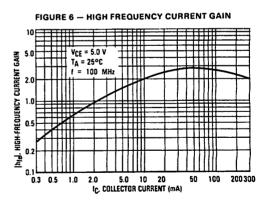












| Rating | Symbol | MPSA42 | MPSA43 | Unit |
|---|----------|------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 300 | 200 | Vdc |
| Collector-Base Voltage | VCBO | 300 | 200 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | 6.0 | Vdc |
| Collector Current — Continuous | 1c | 500 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, Tstg | – 55 to | -55 to +150 | |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------|------|
| Thermal Resistance, Junction to Case | RAJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | RAJA | 200 | °C/W |

MPSA42 MPSA43

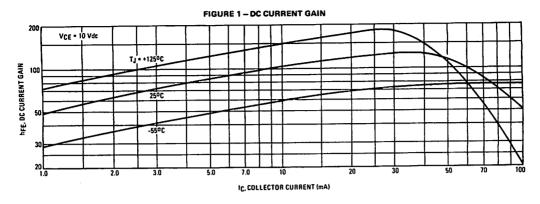
CASE 29-02, STYLE 1 TO-92 (TO-226AA) HIGH VOLTAGE TRANSISTOR

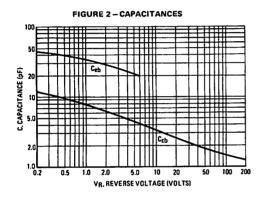
NPN SILICON

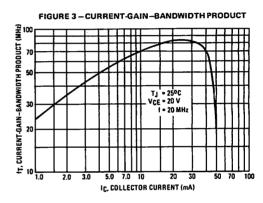
ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

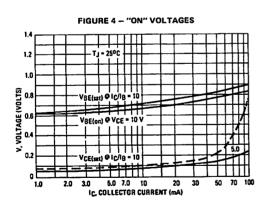
| Characteristic | | Symbol | Min | Max | Unit |
|---|--|----------------------|----------------|---------------|------|
| OFF CHARACTERISTICS | | | | • | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | MPSA42 MPSA43 | V(BR)CEO | 300 200 | | Vdc |
| Collector-Base Breakdown Voltage | MPSA42 MPSA43 | V(BR)CBO | 300 200 | = | Vdc |
| Emitter-Base Breakdown Voltage (Ig = 100 µAdc, IC = 0) | | V(BR)EBO | 6.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 200 Vdc, IE = 0) (VCB = 160 Vdc, IE = 0) | MPSA42 MPSA43 | Ісво | _ | 0.1 0.1 | μAdo |
| Emitter Cutoff Current (VBE = 6.0 Vdc, IC = 0) (VBE = 4.0 Vdc, IC = 0) ON CHARACTERISTICS(1) | MPSA42 MPSA43 | IEBO | _ | 0.1 0.1 | μAdo |
| DC Current Gain (IC = 1.0 mAdc, V _{CE} = 10 Vdc) (IC = 10 mAdc, V _{CE} = 10 Vdc) (IC = 30 mAdc, V _{CE} = 10 Vdc) | Both Types Both Types MPSA42 MPSA43 | hFE | 25 40 40 | <u>-</u> - | _ |
| Collector-Emitter Saturation Voltage (IC = 20 mAdc, Ig = 2.0 mAdc) | MPSA42 MPSA43 | VCE(sat) | 40 | 0.5 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 20 mAdc, IB = 2.0 mAdc) | | V _{BE(sat)} | | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz) | | fT | 50 | _ | MHz |
| Collector-Base Capacitance (V _{CB} = 20 Vdc, I _E = 0, f = 1.0 MHz) | MPSA42 MPSA43 | C _{cb} | | 3.0 4.0 | pF |

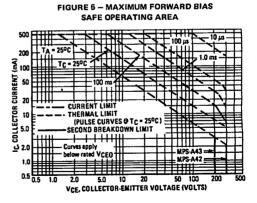
(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.











| Rating | Symbol | MPSA44 | MPSA45 | Unit |
|---|-----------------------------------|-----------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 400 | 350 | Vdc |
| Collector-Base Voltage | V _{CBO} | 500 | 400 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | 6.0 | Vdc |
| Collector Current — Continuous | lc | 3 | 300 | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1 - | 625 5.0 | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 55 to | -55 to +150 | |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------|------|
| Thermal Resistance, Junction to Case | ReJC | 83.3 | °C⁄W |
| Thermal Resistance, Junction to Ambient | RelA | 200 | °C⁄W |

MPSA44 MPSA45

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

HIGH VOLTAGE TRANSISTOR

NPN SILICON

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|--|--|----------------------|----------------------|--------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | MPSA44 MPSA45 | V(BR)CEO | 400 350 | = | Vdc |
| Collector-Emitter Breakdown Voltage (I _C = 100 µAdc, V _{BE} = 0) | MPSA44 MPSA45 | V(BR)CES | 500 400 | | Vdc |
| (IC = 100 \(\pu\)Adc, IE = 0) | MPSA44 MPSA45 | V(BR)CBO | 500 400 | = | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | | V(BR)EBO | 6.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 400 Vdc, IE = 0) (VCB = 320 Vdc, IE = 0) | MPSA44 MPSA45 | ІСВО | = | 0.1 0.1 | μAdc |
| Collector Cutoff Current (VCE = 400 Vdc, VBE = 0) (VCE = 320 Vdc, VBE = 0) | MPSA44 MPSA45 | ICES | _ | 500 500 | nAdc |
| Emitter Cutoff Current (VBE = 4.0 Vdc, I _C = 0) | | IEBO | _ | 0.1 | μAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain(1) (I _C = 1.0 mAdc, V_{CE} = 10 Vdc) (I _C = 10 mAdc, V_{CE} = 10 Vdc) (I _C = 50 mAdc, V_{CE} = 10 Vdc) (I _C = 100 mAdc, V_{CE} = 10 Vdc) | | hFE | 40 50 45 40 | 200 | _ |
| | dc, lg = 0.1 mAdc) lc, lg = 1.0 mAdc) lc, lg = 5.0 mAdc) | VCE(sat) | - | 0.4 0.5 0.75 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = | 1.0 mAdc) | V _{BE(sat)} | _ | 0.75 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Output Capacitance (VCB = 20 Vdc, IE = 0, f = 1.0 f | ИHz) | C _{obo} | | 6.0 | pF |
| Input Capacitance (VEB = 0.5 Vdc, IC = 0, f = 1.0 M | | C _{ibo} | _ | 110 | pF |
| Small-Signal Current Gain (IC = 10 mAdc, VCE = 10 | Vdc, f = 10 MHz) | hfe | 2.0 | _ | _ |

MPSA55, MPSA56

For Specifications, See MPSA05

FIGURE 1 — DC CURRENT GAIN

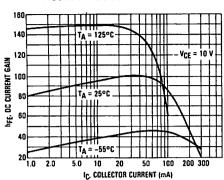


FIGURE 2 — COLLECTOR SATURATION REGION

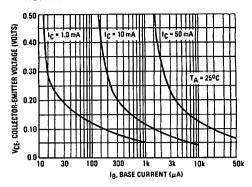


FIGURE 3 — ON VOLTAGES

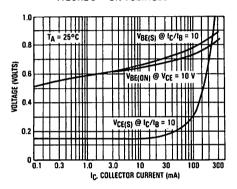


FIGURE 4 — ACTIVE REGION — SAFE OPERATING AREA

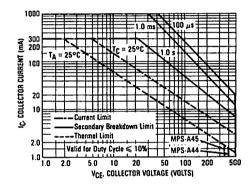


FIGURE 5 — CAPACITANCE

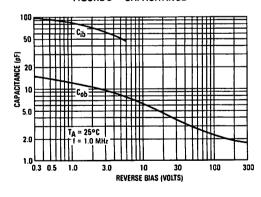


FIGURE 6 - HIGH FREQUENCY CURRENT GAIN

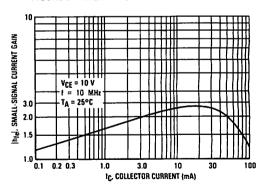
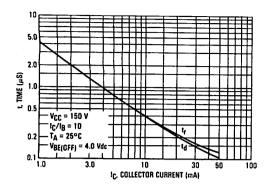


FIGURE 7 — TURN-ON SWITCHING TIMES AND TEST CIRCUIT



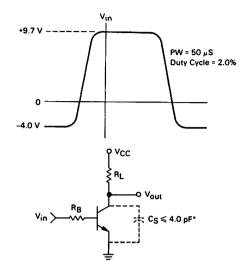
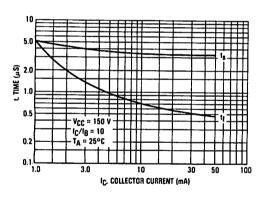
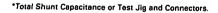
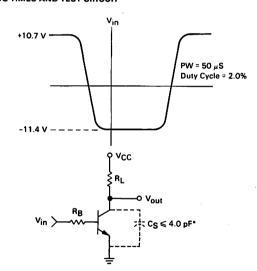


FIGURE 8 — TURN-OFF SWITCHING TIMES AND TEST CIRCUIT







MPSA62 MPSA63 MPSA64

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

DARLINGTON TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| MAXIMON INTINGO | | | | |
|---|----------------------|---------|------------------|----------------|
| Rating | Symbol | MPSA62 | MPSA63 MPSA64 | Unit |
| Collector-Emitter Voltage | VCES | 20 | 30 | Vdc |
| Collector-Base Voltage | V _{CBO} | 20 | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 1 | 0 | Vdc |
| Collector Current — Continuous | lc | 5 | 00 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | | 25 .0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1 ' | .5 2 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | - 55 to | + 150 | •℃ |

THERMAL CHARACTERISTICS

| Γ | Characteristic | Symbol | Max | Unit |
|---|---|--------|------|------|
| 1 | Thermal Resistance, Junction to Case | RøJC | 83.3 | °C/W |
| Г | Thermal Resistance, Junction to Ambient | RAIA | 200 | °C/W |

Refer to MPSA75 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|----------------------------|---------------------|--------------------------|------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 100 µAdc, VBE = 0) | MPSA62 MPSA63, MPSA64 | V(BR)CES | 20 30 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 15 Vdc, !E = 0) (V _{CB} = 30 Vdc, !E = 0) | MPSA62 MPSA63, MPSA64 | ICBO | _ | 100 | nAdc |
| Emitter Cutoff Current (VBE = 10 Vdc, IC = 0) | | IEBO | <u> </u> | 100 | nAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain (IC = 10 mAdc, VCE = 5.0 Vdc) | MPSA63 MPSA64 MPSA62 | hFE | 5000 10,000 20,000 | = | - |
| (IC = 100 mAdc, VCE = 5.0 Vdc) | MPSA63 MPSA64 | | 10,000 20,000 | | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 0.01 mAdc) (IC = 100 mAdc, IB = 0.1 mAdc) | MPSA62 MPSA63, MPSA64 | VCE(sat) | _ | 1.0 1.5 | Vdc |
| Base-Emitter On Voltage (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) (I _C = 100 mAdc, V _{CE} = 5.0 Vdc) | MPSA62 MPSA63, MPSA64 | V _{BE(on)} | _ | 1.4 2.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | ı | , |
| Current-Gain — Bandwidth Product(2) (IC = 100 mAdc, VCE = 5.0 Vdc, f = 100 MHz) | MPSA63, MPSA64 | fT | 125 | _ | MHz |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

⁽²⁾ $f_T = |h_{fe}| \cdot f_{test}$.

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | lc lc | 100 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 200 | °C/W |
| Thermal Resistance, Junction to Case | RAIC | 83.3 | °C/W |

MPSA70

CASE 29-02, STYLE 1 TO-92 (TO-226AA) AMPLIFIER TRANSISTOR

PNP SILICON

Refer to 2N5086 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|------------------|-----|------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 40 | _ | Vdc |
| Emitter-Base Breakdown Voltage (Ig = 100 µAdc, IC = 0) | V(BR)EBO | 4.0 | - | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0) | ICBO | - | 100 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 5.0 mAdc, VCE = 10 Vdc) | hFE | 40 | 100 | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | VCE(sat) | - | 0.25 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | _ |
| Current-Gain — Bandwidth Product (IC = 5.0 mAdc, VCE = 10 Vdc, f = 100 MHz) | fτ | 125 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | C _{obo} | _ | 4.0 | pF |

MPSA75 MPSA76 MPSA77

CASE 29-02 TO-92 (TO-226AA)

DARLINGTON TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

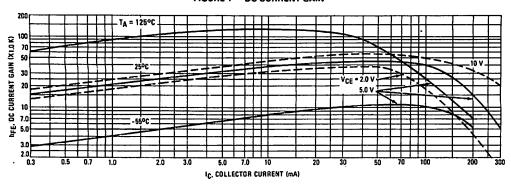
| MAXIMON INTINGO | | | | | |
|--|----------------------|-------------|------------|--------|-------------|
| Rating | Symbol | MPSA75 | MPSA76 | MPSA77 | Unit |
| Collector-Emitter Voltage | VCES | 40 | 50 | 60 | Vdc |
| Emitter-Base Voltage | VEBO | | 10 | | Vdc |
| Collector Current — Continuous | Ic | | 500 | | mAdc |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | | 625 5.0 | | mW mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | | ဇင | |

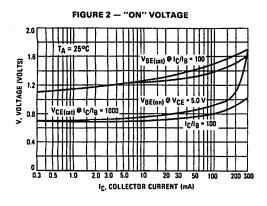
THERMAL CHARACTERISTICS

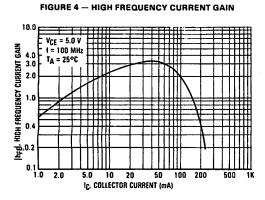
| Characteristic | Symbol | Max | Unit |
|---|--------|-----|------|
| Thermal Resistance, Junction to Ambient | ReJA | 200 | ç |

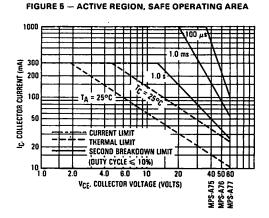
| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|----------------------------|----------------------|------------------|---------------|-------------------|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 100 μAdc, V _{BE} = 0) | MPSA75 MPSA76 MPSA77 | V(BR)CES | 40 50 60 | 111 | - - - | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0) | MPSA75 MPSA76 MPSA77 | V(BR)CBO | 40 50 60 | 111 | = | Vdc |
| Collector Cutoff Current (VCB = 30 V, IE = 0) (VCB = 40 V, IE = 0) (VCB = 50 V, IE = 0) | MPSA75 MPSA76 MPSA77 | ICBO | <u>-</u> | 111 | 100 100 100 | nAdc |
| Collector Cutoff Current (VCE = 30 V, VBE = 0) (VCE = 40 V, VBE = 0) (VCE = 50 V, VBE = 0) | MPSA75 MPSA76 MPSA77 | CES | = | <u>-</u> - | 500 500 500 | nAdc |
| Emitter Cutoff Current (VBE = 10 Vdc) | | lEBO | _ | _ | 100 | nAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain (I _C = 10 mA, V _{CE} = 5.0 V) (I _C = 100 mA, V _{CE} = 5.0 V) | | hFE | 10,000 10,000 | _ | | _ |
| Collector-Emitter Saturation Voltage (IC = 100 mA, IB = 0.1 mAdc) | | V _{CE(sat)} | _ | | 1.5 | Vdc |
| Base-Emitter On Voltage (IC = 100 mA, VCE = 5.0 Vdc) | | VBE | | _ | 2.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current Gain — High Frequency (I _C = 10 mA, V _{CE} = 5.0 V, f = 100 MHz) | | h _{fe} | 1.25 | 2.4 | | |

FIGURE 1 - DC CURRENT GAIN









MPSA92 MPSA93

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

HIGH VOLTAGE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

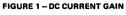
| Rating | Symbol | MPS-A92 | MPS-A93 | Unit |
|---|----------------------|------------|---------|----------------|
| Collector-Emitter Voltage | VCEO | 300 | 200 | Vdc |
| Collector-Base Voltage | VCBO | 300 | 200 | Vdc |
| Emitter-Base Voltage | VEBO | 5 | .0 | Vdc |
| Collector Current — Continuous | lc | 500 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1 ' | .5 2 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | Tj, T _{stg} | -55 to | + 150 | °C |

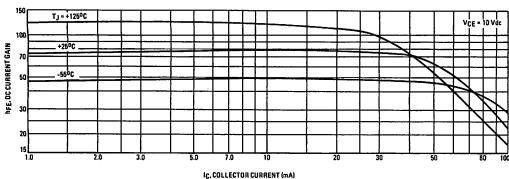
THERMAL CHARACTERISTICS

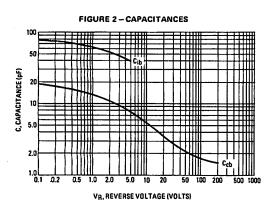
| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Case | Rejc | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 200 | °C/W |

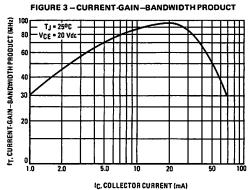
| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------------|----------------------|------------|--------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | MPSA92 MPSA93 | V(BR)CEO | 300 200 | = | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μAdc, IE = 0) | MPSA92 MPSA93 | V(BR)CBO | 300 200 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | | Vdc |
| Collector Cutoff Current (VCB = 200 Vdc, IE = 0) (VCB = 160 Vdc, IE = 0) | MPSA92 MPSA93 | Ісво | <u> </u> | 0.25 0.25 | μAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | | IEBO | _ | 0.1 | μAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc) | Both Types Both Types | pŁE | 25 40 | = | _ |
| (IC = 30 mAdc, VCE = 10 Vdc) | MPSA92 MPSA93 | | 25 25 | _ | |
| Collector-Emitter Saturation Voltage (I _C = 20 mAdc, I _B = 2.0 mAdc) | MPSA92 MPSA93 | V _{CE(sat)} | _ | 0.5 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 20 mAdc, IB = 2.0 mAdc) | | V _{BE(sat)} | - | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz) | | fτ | 50 | _ | MHz |
| Collector-Base Capacitance (VCB = 20 Vdc, I _E = 0, f = 1.0 MHz) | MPSA92 MPSA93 | C _{cb} | _ | 6.0 8.0 | pF |

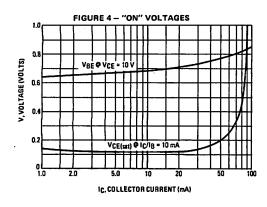
⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

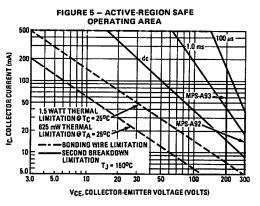












NPN MPSD05 **PNP** MPSD55

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 25 | Vdc |
| Collector-Base Voltage | V _{CBO} | 25 | Vdc |
| Collector Current — Continuous | lc | 600 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | ℃ |

THERMAL CHARACTERISTICS

| THE HIMSE OF STATES OF EACH | | | |
|--------------------------------------|------------------|------|------|
| Characteristic | Symbol | Max | Unit |
| Thermal Resistance, Junction to Case | Raic | 83.3 | °C/W |
| Thermal Resistance, Junction to | R _{ØJA} | 200 | °C⁄W |

Refer to 2N4400 for MPSD05 graphs.*

| Characteristic | Symbol | Min | Max | Unit |
|---|----------|----------------|-------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, Ig = 0) | V(BR)CEO | 25 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, I _E = 0) | V(BR)CBO | 25 | _ | Vdc |
| Collector Cutoff Current (VCE = 20 Vdc) | ICEO | | 1.0 | μAdc |
| Collector Cutoff Current (VCB = 20 Vdc, I _E = 0) | СВО | | 1.0 | μAdc |
| Emitter Cutoff Current (VEB = 3.0 Vdc, IC = 0) | IEBO | _ | 100 | nAdo |
| ON CHARACTERISTICS(2) | | | | |
| DC Current Gain (I _C = 50 mAdc, V _{CE} = 5.0 Vdc) (I _C = 100 mAdc, V _{CE} = 5.0 Vdc) (I _C = 500 mAdc, V _{CE} = 5.0 Vdc) | hFE | 50 80 30 | _ | |
| Collector-Emitter Saturation Voltage (IC = 100 mAdc, IB = 10 mAdc) | VCE(sat) | _ | 0.5 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | ., |
| Current-Gain — Bandwidth Product (I _C = 50 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | fτ | 100 | | MHz |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board. (2) Pulsa Test: Pulse Width < 300 µs, Duty Cycle < 2.0%.
*Refer to 2N4402 for MPSD55 graphs.

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Base Voltage | V _{CBO} | 20 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | lc | 30 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 8.0 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|-------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 83.3 | °C/mW |
| Thermal Resistance, Junction to Ambient | Raja(1) | 200 | °C/mW |

MPSH02

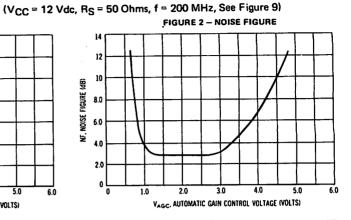
CASE 29-02, STYLE 2 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

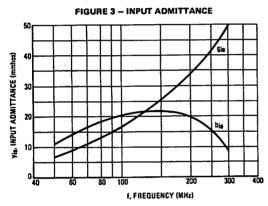
| Characteristic | Symbol | Min | Max | Unit |
|---|-----------------|-----|-----|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 20 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 20 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | V(BR)EBO | 3.0 | | Vdc |
| Collector Cutoff Current (VCB = 10 Vdc, IE = 0) | ICBO | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | · | |
| DC Current Gain (IC = 4.0 mAdc, VCE = 10 Vdc) | pkE | 20 | 200 | - |
| SMALL-SIGNAL CHARACTERISTICS | | ··· | | |
| Current-Gain — Bandwidth Product (IC = 4.0 mAdc, VCE = 10 Vdc, f = 100 MHz) | fT | 375 | | MHz |
| Collector-Base Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz) | C _{cb} | _ | 0.5 | pF |
| Noise Figure (VAGC = 1.4 Vdc, R _S = 50 Ohms, f = 200 MHz) | NF | _ | 3.3 | dB |
| FUNCTIONAL TEST | | | | |
| Amplifier Power Gain (VAGC = 1.4 Vdc, R _S = 50 Ohms, f = 200 MHz) | G _{pe} | 20 | _ | dB |
| Forward AGC Voltage (Gain Reduction = 30 dB, R _S = 50 Ohms, f = 200 MHz) | VAGC | 4.0 | 5.0 | Vdc |

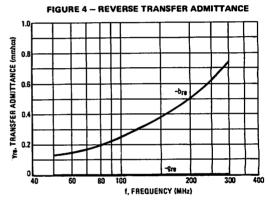
AGC CHARACTERISTICS FIGURE 1 - POWER GAIN 25 20 G. POWER GAIN (dB) 15 10



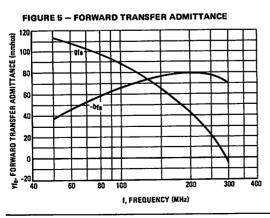
VAGC. AUTOMATIC GAIN CONTROL VOLTAGE (VOLTS)

COMMON-EMITTER y PARAMETERS ($I_C = 4.0 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$, $T_A = 25^{\circ}\text{C}$)





COMMON-EMITTER y PARAMETERS $(I_C = 4.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, T_A = 25^{\circ}\text{C})$



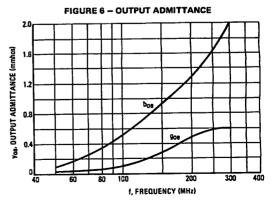
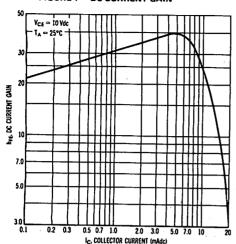


FIGURE 7 - DC CURRENT GAIN



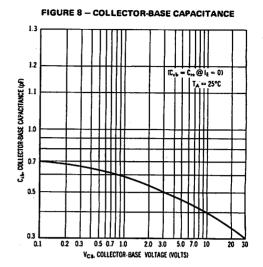
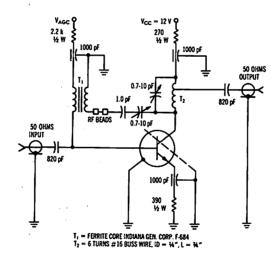


FIGURE 9 - 200 MHz FUNCTIONAL TEST CIRCUIT (NEUTRALIZED)



MPSH04 MPSH05

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|---------------|
| Collector-Emitter Voltage | VCEO | 80 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | lc | 100 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/℃ |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|----------------------|------|------|
| Thermal Resistance, Junction to Case | Resc | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{6JA} (1) | 200 | °C/W |

⁽¹⁾ Raja is measured with the device soldered into a typical printed circuit board.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|------------------|-----------------|----------|-----|------------|-------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 1.0 mAdc, IB = 0) | | V(BR)CEO | 80 | _ | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | | V(BR)CBO | 80 | | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 4.0 | _ | | Vdc |
| Collector Cutoff Current (VCB = 60 Vdc, Ig = 0) | | ІСВО | _ | _ | 50 | nAdc |
| Emitter Cutoff Current (VEB = 3.0 Vdc, IC = 0) | | IEBO | | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain (I _C = 1.5 mAdc, V _{CE} = 10 Vdc) | MPSH04 MPSH05 | ptE | 30 30 | | 120 150 | - |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | | VCE(sat) | _ | _ | 0.25 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Crrent-Gain — Bandwidth Product (IC = 1.5 mAdc, VCE = 10 Vdc, f = 100 MHz) | | fT | 80 | _ | | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, f = 1.0 MHz) | | C _{cb} | _ | _ | 1.6 | pF |
| Output Admittance (IC = 1.5 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | | h _{oe} | _ | _ | 5.0 | μmhos |
| Noise Figure (I _C = 1.5 mAdc, V_{CE} = 10 Vdc, R _S = 50 ohms, f = 1.0 MHz) | MPSH04 | NF | _ | _ | 2.0 | dB |

(2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|-------------|
| Collector-Emitter Voltage | VCEO | 30 | Vdc |
| Collector-Base Voltage | V _{CBO} | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 2.81 | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

OFF CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|--------------------------------------|--------|-----|------|
| Thermal Resistance, Junction to Case | Rejc | 357 | °C/W |

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic

MPSH07 MPSH08

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

FM/VHF TRANSISTOR

NPN SILICON

Max

Unit

dB

mAdc

Min

Symbol

Gpb

IAGC

18

14

6.5

6.5

| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 30 | _ | Vdc |
|--|---------------------------------------|-----|------------|------|
| Collector-Base Breakdown Voltage (I _C = 100 µAdc, I _E = 0) | V(BR)CBO | 30 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 µAdc, I _C = 0) | V(BR)EBO | 3.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) | СВО | | 50 | nAdc |
| ON CHARACTERISTICS | | | <u> </u> | |
| DC Current Gain (IC = 3.0 mAdc, VCE = 10 Vdc) | hFE | 20 | - | _ |
| Base-Emitter On Voltage (IC = 3.0 mAdc, VCE = 10 Vdc) | V _{BE(on)} | _ | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 3.0 mAdc, VCE = 10 Vdc, f = 100 MHz) | ft | 400 | _ | MHz |
| Collector-Emitter Capacitance (VCE = 10 Vdc, Ig = 0, f = 1.0 MHz, base guarded) | C _{ce} (C _{rb}) | _ | 0.3 | pF |
| Noise Figure (I _C = 3.0 mAdc, V _{CB} = 10 Vdc, R _S = 50 Ohms, f = 100 MHz) MPS-H07 (I _C = 3.0 mAdc, V _{CB} = 10 Vdc, R _S = 50 Ohms, f = 200 MHz) MPS-H08 | NF | = | 3.0 3.0 | dB |
| FUNCTIONAL TEST | | | | |

MPS-H07

MPS-H08

MPS-H07

MPS-H08

Forward AGC Current

Common-Emitter Amplifier Power Gain

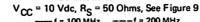
 $(I_C=3.0 \text{ mAdc}, V_{CB}=10 \text{ Vdc}, R_S=50 \text{ Ohms}, f=100 \text{ MHz})$ $(I_C=3.0 \text{ mAdc}, V_{CB}=10 \text{ Vdc}, R_S=50 \text{ Ohms}, f=200 \text{ MHz})$

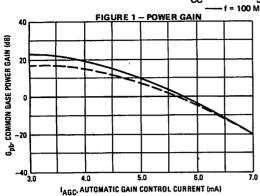
(Gain Reduction = 30 dB, R_S = 50 Ohms, f = 100 MHz) (Gain Reduction = 30 dB, R_S = 50 Ohms, f = 200 MHz)

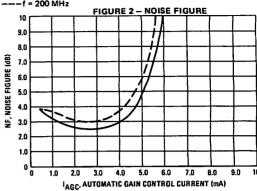
8.5

8.5

AGC CHARACTERISTICS







COMMON-BASE y PARAMETERS

--- f = 100 MHz ---- f = 200 MHz

FIGURE 3 - INPUT ADMITTANCE

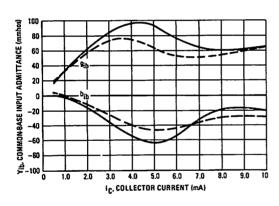


FIGURE 4 - REVERSE TRANSFER ADMITTANCE

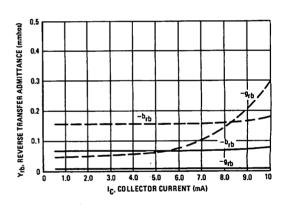


FIGURE 5 - FORWARD TRANSFER ADMITTANCE

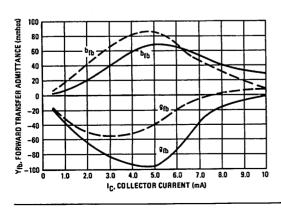


FIGURE 6 - OUTPUT ADMITTANCE

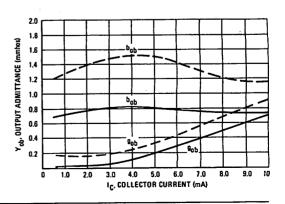


FIGURE 7 - COLLECTOR-BASE TIME CONSTANT

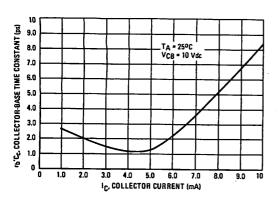


FIGURE 8 - CURRENT-GAIN BANDWIDTH PRODUCT

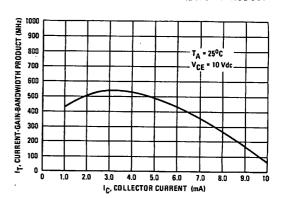
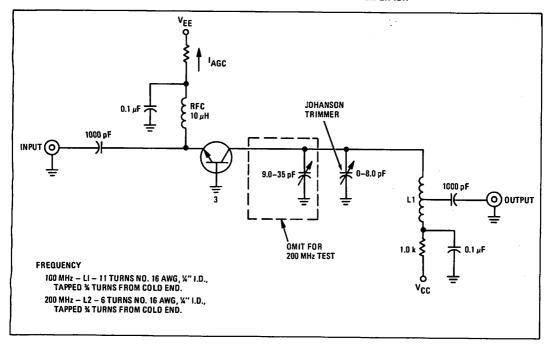


FIGURE 9 - 100-MHz AND 200-MHz COMMON-BASE AMPLIFIER



MPSH10 MPSH11

CASE 29-02, STYLE 2 TO-92 (TO-226AA)

VHF/UHF TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|---------------|
| Collector-Emitter Voltage | VCEO | 25 | Vdc |
| Collector-Base Voltage | V _{CBO} | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

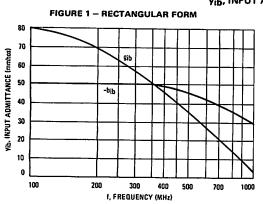
| *************************************** | | | |
|---|------------------|-----|------|
| Characteristic | Symbol | Max | Unit |
| Thermal Resistance, Junction to Case | R _{ØJC} | 125 | °C/W |
| Thermal Resistance, Junction to Ambient | RAJA | 357 | °C/W |

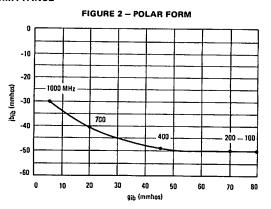
| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------|-------------------|-------------|-------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) | | V(BR)CEO | 25 | | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0) | | V(BR)CBO | 30 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | | V(BR)EBO | 3.0 | | Vdc |
| Collector Cutoff Current (VCB = 25 Vdc, IE = 0) | | СВО | _ | 100 | nAdc |
| Emitter Cutoff Current (VBE = 2.0 Vdc, IC = 0) | | l _{EBO} | _ | 100 | пAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 4.0 mAdc, VCE = 10 Vdc) | | hFE | 60 | _ | _ |
| Collector-Emitter Saturation Voltage (IC = 4.0 mAdc, IB = 0.4 mAdc) | | VCE(sat) | _ | 0.5 | Vdc |
| Base-Emitter On Voltage (IC = 4.0 mAdc, VCE = 10 Vdc) | | VBE | _ | 0.95 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 4.0 mAdc, VCE = 10 Vdc, f = 100 MHz) | | fτ | 650 | | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | | C _{cb} | _ | 0.7 | pF |
| Common-Base Feedback Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | MPS-H10 MPS-H11 | C _{rb} | 0.35 0.6 | 0.65 0.9 | pF |
| Collector Base Time Constant (IC = 4.0 mAdc, VCB = 10 Vdc, f = 31.8 MHz) | | rb'C _C | _ | 9.0 | ps |

COMMON-BASE y PARAMETERS versus FREQUENCY

 $(V_{CB} = 10 \text{ Vdc}, I_{C} = 4.0 \text{ mAdc}, T_{A} = 25^{\circ}\text{C})$

yib, INPUT ADMITTANCE

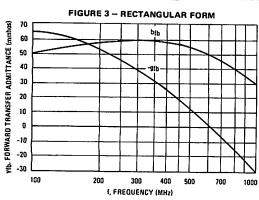


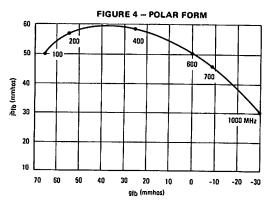


COMMON-BASE y PARAMETERS versus FREQUENCY

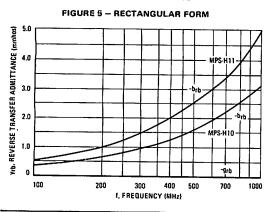
 $(V_{CB} = 10 \text{ Vdc}, I_{C} = 4.0 \text{ mAdc}, T_{A} = 25^{\circ}\text{C})$

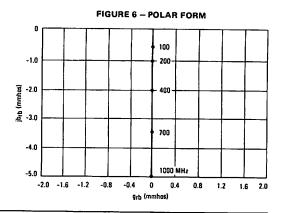
уfь, FORWARD TRANSFER ADMITTANCE



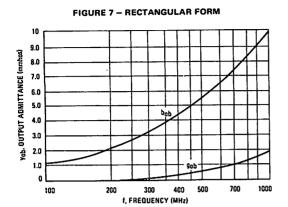


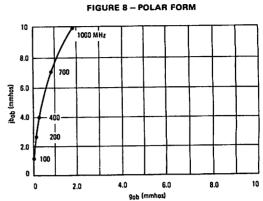
yrb, REVERSE TRANSFER ADMITTANCE





Yob, OUTPUT ADMITTANCE





| THE STATE OF THE S | | | |
|--|-----------------------------------|-------------|-------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 15 | Vdc |
| Collector-Base Voltage | VCBO | 20 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | ° |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|--|------------------|-----|------|
| Thermal Resistance, Junction to Ambient (Printed Circuit Board Mounting) | R _{ØJA} | 200 | °C/W |

MPSH17

CASE 29-02, STYLE 2 TO-92 (TO-226AA)

CATV TRANSISTOR

NPN SILICON

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|----------------------|-----|-----|----------|------|
| OFF CHARACTERISTICS | | | | | , |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 15 | - | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 20 | - | | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | V(BR)EBO | 3.0 | _ | - | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) | СВО | _ | _ | 100 | nAdc |
| ON CHARACTERISTICS | | | - | · | L |
| DC Current Gain (I _C = 5.0 mAdc, V _{CE} = 10 Vdc) | hFE | 25 | _ | 250 | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | V _{CE(sat)} | _ | | 0.5 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | - | | <u> </u> | |
| Current-Gain — Bandwidth Product (IC = 5.0 mAdc, VCE = 10 Vdc, f = 100 MHz) | ſΤ | 800 | _ | _ | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, f = 1.0 MHz) | C _{cb} | 0.3 | _ | 0.9 | pF |
| Small-Signal Current Gain (I _C = 5.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{fe} | 30 | | - | _ |
| Noise Figure (IC = 5.0 mAdc, V_{CC} = 12 Vdc, R_S = 50 ohms, f = 200 MHz) | NF | _ | _ | 6.0 | dB |
| FUNCTIONAL TEST | | | | | |
| Amplifier Power Gain (IC = 5.0 mAdc, V _{CC} = 12 Vdc, R _S = 50 ohms, f = 200 MHz) | G _{pe} | _ | 24 | _ | dB |

MPSH20

CASE 29-02, STYLE 2 TO-92 (TO-226AA)

VHF TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| WAXINGW TATINGS | | | | |
|--|----------------------|-------------|----------------|--|
| Rating | Symbol | Value | Unit | |
| Collector-Emitter Voltage | VCEO | 30 | Vdc | |
| Collector-Base Voltage | VCBO | 40 | Vdc | |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc | |
| Collector Current — Continuous | lc | 100 | mAdc | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 2.81 | mW/°C | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 8.0 | Watts mW/°C | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | ~ •℃ | |

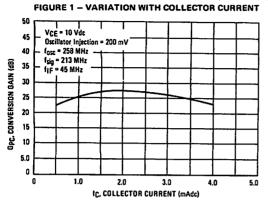
THERMAL CHARACTERISTICS

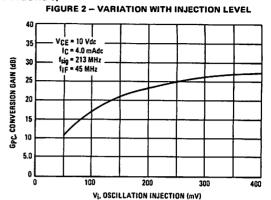
| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Case | ReJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 357 | °C/W |

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|-------------------|-----|-----|------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) | V(BR)CEO | 30 | _ | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 40 | - | | Vdc |
| Emitter-Base Breakdown Voltage (Ip = 10 µAdc, Ic = 0) | V(BR)EBO | 4.0 | _ | | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) | СВО | - | | 50 | nAdc |
| ON CHARACTERISTICS | | , | | | |
| DC Current Gain (IC = 4.0 mAdc, VCE = 10 Vdc) | hFE | 25 | | | |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 4.0 mAdc, VCE = 10 Vdc, f = 100 MHz) | fτ | 400 | 620 | _ | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | C _{cb} | | 0.5 | 0.65 | pF |
| Collector Base Time Constant (I _E = 4.0 mAdc, V _{CB} = 10 Vdc, f = 31.8 MHz) | rb'C ^C | _ | 10 | _ | ps |
| Conversion Gain (213 to 45 MHz) (IC = 4.0 mAdc, VCE = 10 Vdc, Oscillator Injection = 200 mVdc) | | 18 | 23 | _ | dB |

CONVERSION GAIN CHARACTERISTICS

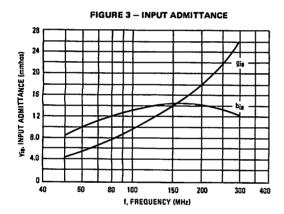
(TEST CIRCUIT FIGURE 9)

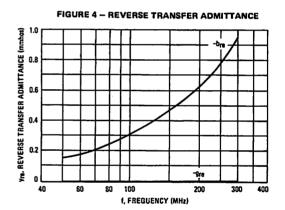




COMMON-EMITTER y PARAMETERS

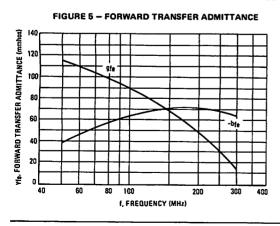
 $(I_C = 4.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, T_A = 25^{\circ}\text{C})$

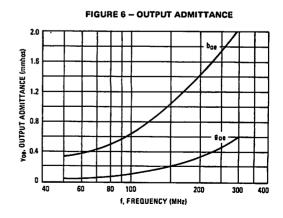


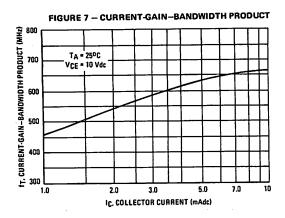


COMMON-EMITTER y PARAMETERS

 $(I_C = 4.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, T_A = 25^{\circ}\text{C})$







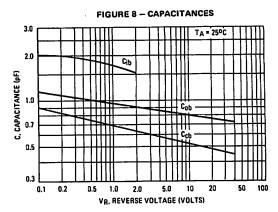
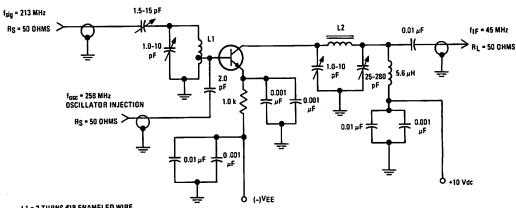


FIGURE 9 - MIXER TEST CIRCUIT



L1 = 3 TURNS #18 ENAMELED WIRE, 1/4" I.D., AIR WOUND, WINDING LENGTH 1/2"; BASE TAPPED 1 TURN FROM GROUND.

L2 = 10 TURNS #26 INSULATED WIRE, WOUND ON 1/4" I.O. COIL FORM, ARNOLD PART NO. A1-10 IRON POWDER CORE.

| HIPOGHIOHI IOTHIAGO | | | |
|---|----------------------|-------------|------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 30 | Vdc |
| Collector-Base Voltage | V _{CBO} | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | l _C | 100 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/℃ |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +135 | °C |

MPSH24

CASE 29-02, STYLE 2 TO-92 (TO-226AA)

VHF TRANSISTOR

NPN SILICON

THERMAL CHARACTERISTICS

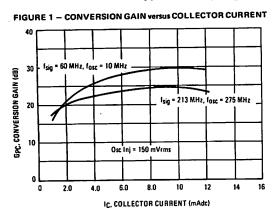
| Characteristic | Symbol | Max | Unit |
|---|--------|-----|------|
| Thermal Resistance, Junction to Ambient | RAJA | 357 | °C/W |

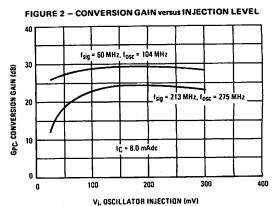
| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|-----------------|------------|----------|----------|-------------|
| OFF CHARACTERISTICS | | | | <u> </u> | · |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, Ig = 0) | V(BR)CEO | 30 | _ | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μAdc, I _E = 0) | V(BR)CBO | 40 | _ | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | V(BR)EBO | 4.0 | _ | - | Vdc |
| Collector Cutoff Current {VCB = 15 Vdc, I _E = 0} | ICBO | - , | | 50 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 8.0 mAdc, VCE = 10 Vdc) | hFE | 30 | _ | - | |
| SMALL-SIGNAL CHARACTERISTICS | | · | <u> </u> | | |
| Current-Gain — Bandwidth Product (IC = 8.0 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | fτ | 400 | 620 | | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, Ig = 0, f = 1.0 MHz) | C _{cb} | _ | 0.25 | 0.36 | pF |
| Conversion Gain (213 MHz to 45 MHz) | _ | | | | dB |
| (I _C = 8.0 mAdc, V _{CC} = 20 Vdc, Oscillator Injection = 150 mVrms) (60 MHz to 45 MHz) | | 19 | 24 | _ | |
| (IC = 8.0 mAdc, VCC = 20 Vdc, Oscillator Injection = 150 mVrms) | | 24 | 29 | _ | |

CONVERSION GAIN CHARACTERISTICS

(TEST CIRCUIT FIGURE 7)

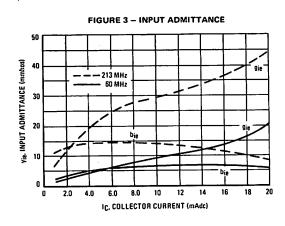
(V_{CC} = 20 Vdc, R_S = R_L = 50 Ohms, f_{if} = 44 MHz, B.W. = 6.0 MHz)

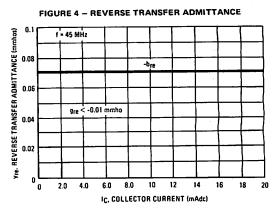


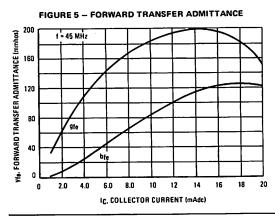


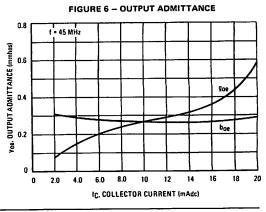
COMMON-EMITTER y PARAMETERS

 $(VCE = 15 Vdc, TA = 25^{\circ}C)$



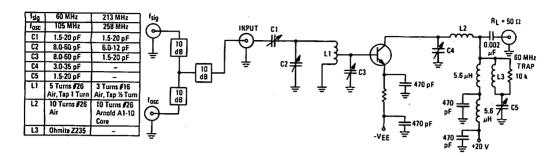






SMALL-SIGNAL DEVICES

FIGURE 7 - VHF MIXER TEST CIRCUIT (f_{if} = 44 MHz, B.W. = 6.0 MHz)



MPSH30 MPSH31

CASE 29-02, STYLE 2 TO-92 (TO-226AA)

IF AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|----------------------|-------------|---------------|
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Base Voltage | VCBO | 20 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | !c | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12.0 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | ℃ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|----------------------|------|------|
| Thermal Resistance, Junction to Case | ReJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{EJA} (1) | 200 | °CW |

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|------------|------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) | V(BR)CEO | 20 | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 20 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 µAdc, I _C = 0) | V(BR)EBO | 3.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 10 Vdc, IE = 0) | ICBO | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 4.0 mAdc, V _{CE} = 5.0 Vdc) | hFE | 20 | 200 | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 5.0 mAdc) | VCE(sat) | 0.1 | 3.0 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 5.0 mAdc) | V _{BE(sat)} | 1 | 0.96 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (I _C = 4.0 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | fT | 300 | 800 | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz, emitter guarded) | C _{cb} | ı | 0.65 | pF |
| Noise Figure (VAGC = 2.75 Vdc, R _S = 50 ohms, f = 45 MHz) | NF | - | 6.0 | dB |
| FUNCTIONAL TESTS | | | | |
| Power Gain (VAGC = 2.75 Vdc, R _S = 50 ohms, f = 45 MHz) | Gpe | 22.5 | 31 | dB |
| Forward AGC Voltage (Gain Reduction = 30 dB, R _S = 50 ohms, f = 45 MHz) MPS-H30 MPS-H31 | VAGC | 4.4 5.2 | 5.4 6.2 | Vdc |

⁽¹⁾ R_{8JA} is measured with the device soldered into a typical printed circuit board.

| WAANION HATIIGS | | | | | |
|---|----------------------|-------------|-------------|--|--|
| Rating | Symbol | Value | Unit | | |
| Collector-Emitter Voltage | VCEO | 30 | Vdc | | |
| Collector-Base Voltage | V _{CBO} | 40 | Vdc | | |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C | | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +135 | °C | | |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Case | RAJC | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 200 | °C/W |

MPSH32

CASE 29-02, STYLE 2 TO-92 (TO-226AA)

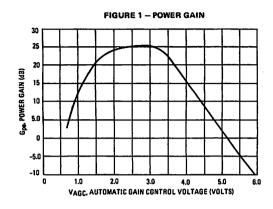
VHF TRANSISTOR

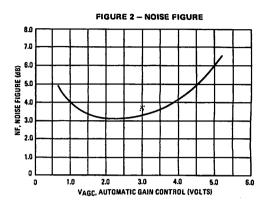
NPN SILICON

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|--|------|-----|------|----------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 30 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 40 | _ | | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 µAdc, IC = 0) | V(BR)EBO | 4.0 | | _ | Vdc |
| Collector Cutoff Current (VCB = 10 Vdc, IE = 0) | ICBO | _ | | 50 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 4.0 mAdc, VCE = 5.0 Vdc) | hFE | 27 | 35 | 200 | — |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 5.0 mAdc) | V _{CE(sat)} | _ | 1.5 | 3.0 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 5.0 mAdc) | V _{BE(sat)} | _ | 0.9 | 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 4.0 mAdc, VCE = 10 Vdc, f = 100 MHz) | fτ | 300 | 440 | - | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) (Emitter Guarded) | C _{cb} | _ | 0.2 | 0.22 | pF |
| Noise Figure (IE~4.0 mAdc, V _{CE} ~9.3 Vdc, V _{AGC} = 2.75 Vdc, R _S = 50 Ohms, f = 45 MHz) | NF | _ | 3.3 | _ | dB |
| FUNCTIONAL TEST | | | • | | |
| Amplifier Power Gain (IE~4.0 mAdc, V _{CE} ~9.3 Vdc, V _{AGC} = 2.75 Vdc, R _S = 50 Ohms, f = 45 MHz) | Gpe | 22.5 | 25 | _ | dB |
| Forward AGC Voltage (Gain Reduction = 30 dB, R _S = 50 Ohms, f = 45 MHz) | VAGC | _ | 5.5 | - | Vdc |
| SUMMARY-COMMON EMITTER PARAMETERS (VCE = 10 Vdc, IC = 4.0 mAd | c, f = 45 MHz) | *. | | | |
| Input Conductance | 9ie | _ | 6.0 | _ | mmhos |
| Input Capacitance | C _{ieo} | | 33 | _ | pF |
| Forward Transfer Admittance Magnitude | lYfel | _ | 110 | | mmhos |
| Forward Transfer Admittance Phase Angle | <yfe< td=""><td></td><td>-22</td><td>_</td><td>Degrees</td></yfe<> | | -22 | _ | Degrees |
| Feedback Capacitance | C _{re} | | 0.2 | - | pF |
| Output Conductance | 9oe | | 20 | _ | μmhos |
| Output Capaticance | Coe | _ | 1.4 | _ | рF |
| Maximum Unilateralized Power Gain $G_{um} = \frac{ y_{fe} ^2}{4 \text{ Gie } 9_{Oe}}$ | G _{um} | _ | 44 | _ | dB |

AGC CHARACTERISTICS

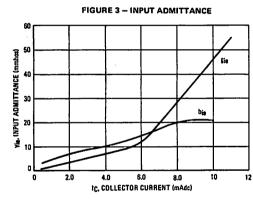
VCC = 12 Vdc, Rs = 50 Ohms, f = 45 MHz, See Figure 10

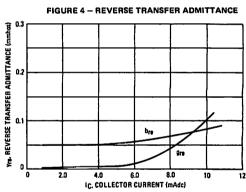


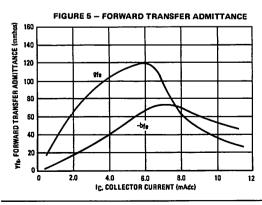


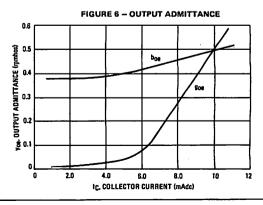
COMMON-EMITTER y PARAMETERS

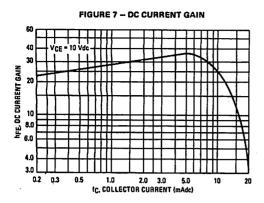
 $V_{CE} = 10 \text{ Vdc}$, f = 45 MHz, $T_A = 25^{\circ}\text{C}$

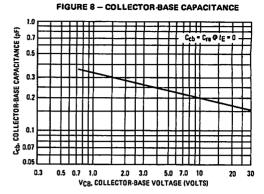












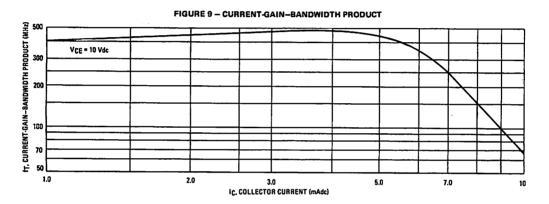
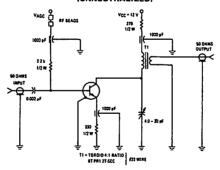


FIGURE 10 – 45 MHz FUNCTIONAL TEST CIRCUIT (UNNEUTRALIZED)



MPSH34

CASE 29-02, STYLE 2 TO-92 (TO-226AA)

IF TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| HOWINGH INTHIOS | | | |
|---|-----------------------------------|-------------|-------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 45 | Vdc |
| Collector-Base Voltage | VCBO | 45 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | IC | 100 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +135 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|-----|------|
| Thermal Resistance, Junction to Ambient | ReJA | 357 | •c⁄w |

Refer to MPSH24 for graphs.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|-----------------------|----------|------|------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) | V(BR)CEO | 45 | _ | - | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0) | V _(BR) CBO | 45 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | V(BR)EBO | 4.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0) | IСВО | - | - | 50 | nAdc |
| ON CHARACTERISTICS | | | | • | |
| DC Current Gain (I _C = 7.0 mAdc, V _{CE} = 15 Vdc) (I _C = 20 mAdc, V _{CE} = 2.0 Vdc) | hFE | 40 15 | = | = | _ |
| Collector-Emitter Saturation Voltage (I _C = 20 mAdc, I _B = 2.0 mAdc) | V _{CE(sat)} | ı | _ | 0.5 | Vdc |
| Base-Emitter On Voltage (I _C = 7.0 mAdc, V _{CE} = 15 Vdc) | V _{BE(on)} | 1 | _ | 0.95 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (I _C = 15 mAdc, V _{CE} = 15 Vdc, f = 100 MHz) | fτ | 500 | 720 | _ | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | C _{cb} | - | 0.25 | 0.32 | pF |
| Current-Gain — Bandwidth Ratio (I _C = 15 mAdc to I _C = 20 mAdc, V _{CE} = 15 Vdc) | <u>fт15</u> fт20 | _ | _ | 1.6 | _ |

| Rating | Symbol | Value | Unit |
|---|----------------------|-------------|---------------|
| Collector-Emitter Voltage | VCEO | 80 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | lc | 100 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watt mW/°C |
| Operating and Storage Junction | TJ, T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| *************************************** | | | |
|---|----------------------|------|------|
| Characteristic | Symbol | Max | Unit |
| Thermal Resistance, Junction to Case | R _{ØJC} | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 200 | °C/W |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

MPSH54 MPSH55

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

PNP SILICON

| ELECTRICAL CHARACTERISTICS (TA = | 25°C unless otherwise noted.) |
|----------------------------------|-------------------------------|
|----------------------------------|-------------------------------|

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|----------------------|----------|-----|------------|-------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 80 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 80 | _ | - | Vdc |
| Emitter-Base Breakdown Voltage (Ig = 100 µAdc, IC = 0) | V(BR)EBO | 4.0 | _ | - | Vdc |
| Collector Cutoff Current (VCB = 60 Vdc, Ig = 0) | ІСВО | - | _ | 50 | nAdc |
| Emitter Cutoff Current (VEB = 3.0 Vdc, IC = 0) | ^I EBO | _ | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 1.5 mAdc, V _{CE} = 10 Vdc) MPSH54 MPSH55 | ptē | 30 30 | - = | 120 150 | - |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | V _{CE(sat)} | _ | _ | 0.25 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 1.5 mAdc, VCE = 10 Vdc, f = 100 MHz) | fτ | 80 | - | _ | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, f = 1.0 MHz) | C _{cb} | . – | _ | 1.6 | pF |
| Output Admittance (IC = 1.5 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{oe} | _ | _ | 15 | μmhos |
| Noise Figure (IC = 1.5 mAdc, VCF = 10 Vdc, RS = 50 ohms; f = 1.0 MHz) MPSH54 | NF | _ | - | 2.0 | dB |

MPSH81

CASE 29-02, STYLE 2 TO-92 (TO-226AA)

RF AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|-------------|
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Base Voltage | VCBO | 20 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 2.81 | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

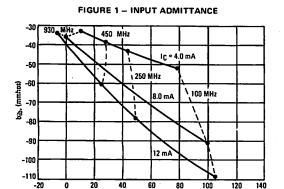
THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|-----|------|
| Thermal Resistance, Junction to Ambient | RAJA | 357 | °CW |

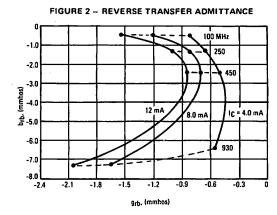
| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------------------|-----|----------|------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, Ig = 0) | V(BR)CEO | 20 | _ | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 20 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 μAdc, IC = 0) | V(BR)EBO | 3.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 10 Vdc, Ig = 0) | Ісво | _ | _ | 100 | nAdc |
| Emitter Cutoff Current (VBE = 2.0 Vdc, I _C = 0) | IEBO | _ | _ | 100 | nAdc |
| ON CHARACTERISTICS | | | v | | |
| DC Current Gain (IC = 5.0 mAdc, VCE = 10 Vdc) | hFE | 60 | _ | _ | _ |
| Collector-Emitter Saturation Voltage (IC = 5.0 mAdc, IB = 0.5 mAdc) | V _{CE(sat)} | _ | | 0.5 | Vdc |
| Base-Emitter On Voltage (IC = 5.0 mAdc, VCE = 10 Vdc) | V _{BE(on)} | _ | | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 5.0 mAdc, VCE = 10 Vdc, f = 100 MHz) | fτ | 600 | _ | _ | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | C _{Cb} | _ | _ | 0.85 | pF |
| Collector-Emitter Capacitance (IB = 0, VCB = 10 Vdc, f = 1.0 MHz) | C _{ce} | _ | _ | 0.65 | pF |

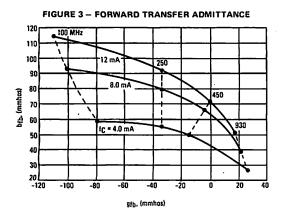
TYPICAL COMMON-BASE y-PARAMETERS

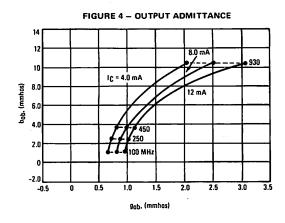
(VCB = 10 Vdc, TA = 25°C, Frequency Points in MHz)

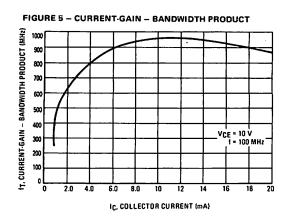


gib, (mmhos)









MPSL01

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|----------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 120 | Vdc |
| Collector-Base Voltage | VCBO | 140 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 150 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, Tstg | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | RAIA | 200 | •cw |

Refer to 2N5550 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|-----|--------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 120 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 140 | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | Vđc |
| Collector Cutoff Current (VCB = 75 Vdc, IE = 0) | Ісво | | 1.0 | μAdc |
| Emitter Cutoff Current (VEB = 4.0 Vdc, IC = 0) | IEBO | _ | 100 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain(1) (IC = 10 mAdc, VCE = 5.0 Vdc) | hFE | 50 | 300 | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc) | VCE(sat) | = | 0.20 0.30 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) (IC = 50 mAdc, Ig = 5.0 mAdc)(1) | V _{BE(sat)} | _ | 1.2 1.4 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | • | | | |
| Current-Gain — Bandwidth Product(1) (IC = 10 mAdc, VCE = 10 Vdc, f = 100 MHz) | fŢ | 60 | _ | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | C _{cb} | _ | 8.0 | рF |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{fe} | 30 | _ | |

⁽¹⁾ Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 100 | Vdc |
| Collector-Base Voltage | VCBO | 100 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | lc | 600 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 12.0 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Case | Rejc | 83.3 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 200 | °C/W |

MPSL51

CASE 29-02, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

PNP SILICON

Refer to 2N5400 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|----------------------|----------|--------------|------|
| OFF CHARACTERISTICS | | | • | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 100 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, I _E = 0) | V(BR)CBO | 100 | - | Vdc |
| Emitter-Base Breakdown Voltage (ΙΕ = 10 μAdc, ΙC = 0) | V(BR)EBO | 4.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) | ІСВО | _ | 1.0 | μAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | [†] EBO | _ | 100 | nAdc |
| ON CHARACTERISTICS(1) | | | | |
| DC Current Gain(1) (IC = 50 mAdc, V _{CE} = 5.0 Vdc) | hfE | 40 | 250 | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) (IC = 50 mAdc, Ig = 5.0 mAdc) | VCE(sat) | _ | 0.25 0.30 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, I _B = 1.0 mAdc) (IC = 50 mAdc, I _B = 5.0 mAdc) | V _{BE(sat)} | <u>-</u> | 1.2 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 10 Vdc, f = 100 MHz) | fī | 60 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, !g = 0, f = 1.0 MHz) | C _{obo} | | 8.0 | pF |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{fe} | 20 | _ | _ |

⁽¹⁾ Pulse Test: Pulse Test = 300 μ s, Duty Cycle = 2.0%.

MPSW01 MPSW01A

CASE 29-03, STYLE 1 TO-92 (TO-226AE)

HIGH CURRENT TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MAXIMUM KATINGS | | | |
|---|-----------------------------------|-------------|---------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage MPSW01 MPSW01A | VCEO | 30 40 | Vdc |
| Collector-Base Voltage MPSW01 MPSW01A | VCBO | 40 50 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 1000 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/℃ |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.5 20 | Watts mW/℃ |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | ပ္ |

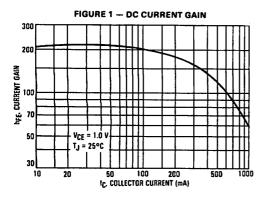
THERMAL CHARACTERISTICS

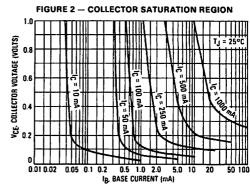
| Characteristic | Symbol | Max | Unit |
|---|------------------|-----|------|
| Thermal Resistance, Junction to Case | ReJC | 50 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 125 | °CW |

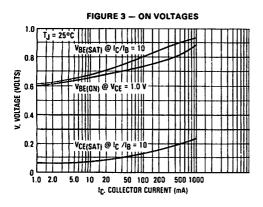
| Characteristic | | Symbol | Min | Max | Unit |
|--|-------------------|---------------------|----------------|------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, Ig = 0) | MPSW01 MPSW01A | V(BR)CEO | 30 40 | = | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μAdc, IE = 0) | MPSW01 MPSW01A | V(BR)CBO | 40 50 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0) (VCB = 40 Vdc, IE = 0) | MPSW01 MPSW01A | ІСВО | - | 0.1 0.1 | μAdc |
| Emitter Cutoff Current (VEB = 3.0 Vdc, I _C = 0) | | IEBO | _ | 0.1 | μAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) (I _C = 100 mAdc, V _{CE} = 1.0 Vdc) (I _C = 1000 mAdc, V _{CE} = 1.0 Vdc) | | pŁE | 55 60 50 | - | - |
| Collector-Emitter Saturation Voltage (IC = 1000 mAdc, IB = 100 mAdc) | | VCE(sat) | - | 0.5 | Vdc |
| Base-Emitter On Voltage (IC = 1000 mAdc, VCE = 1.0 Vdc) | | V _{BE(on)} | _ | 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 10 Vdc, f = 20 MHz) | | fτ | 50 | | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | | C _{obo} | _ | 20 | pF |

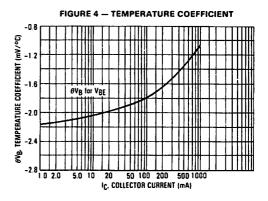
⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

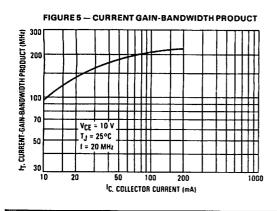
MPSW01, MPSW01A

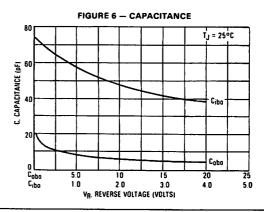


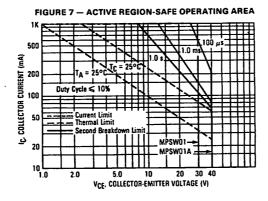












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|--|-----------------------------------|------------|-------------|----------------|
| Rating | Symbol | MPSW05 | MPSW06 | Unit |
| Collector-Emitter Voltage | VCEO | 60 | 80 | Vdc |
| Collector-Base Voltage | VCBO | 60 | 80 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | | Vdc |
| Collector Current — Continuous | lc | 500 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.5 20 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to | -55 to +150 | |

MPSW05 MPSW06

CASE 29-03, STYLE 1 TO-92 (TO-226AA)

AMPLIFIER TRANSISTOR

NPN SILICON

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|-----|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 50 | °C/W |
| Thermal Resistance, Junction to Ambient | RAIA | 125 | °C/W |

| Characteristic | · | Symbol | Min | Max | Unit |
|---|---|----------------------|----------|------------|------|
| OFF CHARACTERISTICS | | | | | · |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | MPSW05 MPSW06 | V(BR)CEO | 60 80 | = | Vdc |
| (IE = 100 µAdc, IC = 0) | | V(BR)EBO | 4.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 40 Vdc, lg = 0) (VCE = 60 Vdc, lg = 0) | MPSW05 MPSW06 | (CEO | | 0.5 0.5 | μAdc |
| Collector Cutoff Current (VCB = 40 Vdc, IE = 0) (VCB = 60 Vdc, IE = 0) | MPSW05 MPSW06 | ІСВО | = | 0.1 0.1 | μAdc |
| Emitter Cutoff Current (VEB = 3.0 Vdc, IC = 0) | | IEBO | _ | 0.1 | μAdc |
| ON CHARACTERISTICS(1) DC Current Gain (IC = 50 mAdc, VCE = 1.0 Vdc) (IC = 250 mAdc, VCE = 1.0 Vdc) | , , , , , , , , , , , , , , , , , , , | hee | 80 60 | = | - |
| Collector-Emitter Saturation Voltage (IC = 250 mAdc, Ig = 10 mAdc) | | VCE(sat) | _ | 0.40 | Vdc |
| Base-Emitter Saturation Voltage (IC = 250 mAdc, VCE = 5.0 Vdc) | | V _{BE(sat)} | _ | 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 200 mAdc, V _{CE} = 5.0 Vdc, f = 20 MHz) | | fτ | 50 | _ | MHz |
| Output Capecitance (VCB = 10 V, f = 1.0 MHz) | | Cobo | _ | 12 | pF |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MPSW10

CASE 29-03, STYLE 1 TO-92 (TO-226AE)

HIGH VOLTAGE TRANSISTOR

MAXIMUM RATINGS

| TIP CHILLICAL TEXT TO THE COLUMN TEXT TEXT TO THE COLUMN TEXT TEXT TEXT TEXT TEXT TEXT TEXT TEX | | | |
|--|-----------------------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 300 | Vdc |
| Collector-Base Voltage | VCBO | 300 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | Vdc |
| Collector Current — Continuous | lc | 500 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.5 20 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|-----|------|
| Thermal Resistance, Junction to Case | Rejc | 50 | •c/w |
| Thermal Resistance, Junction to Ambient | Raja | 125 | °C/W |

Refer to MPSW42 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|----------------|------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 300 | _ | Vđc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 300 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 µAdc, IC = 0) | V(BR)EBO | 6.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 200 Vdc, IE = 0) | ICBO | _ | 0.2 | μAdc |
| Emitter Cutoff Current (VEB = 6.0 Vdc, I _C = 0) | l _{EBO} | _ | 0.1 | μAdc |
| ON CHARACTERISTICS(1) | | | | |
| DC Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc) (IC = 10 mAdc, VCE = 10 Vdc) (IC = 30 mAdc, VCE = 10 Vdc) | hFE | 25 40 40 | = | _ |
| Collector-Emitter Saturation Voltage (IC = 30 mAdc, Ig = 3.0 mAdc) | VCE(sat) | _ | 0.75 | Vdc |
| Base-Emitter On Voltage (IC = 30 mAdc, VCE = 10 Vdc) | VBE(on) | _ | 0.85 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 20 MHz) | fτ | 45 | _ | MHz |
| Collector-Base Capacitance (VCB = 20 Vdc, tg = 0, f = 1.0 MHz) | C _{cb} | _ | 3.0 | pF |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| Rating | Symbol | Value | Unit |
|---|----------------------|-------------|----------------|
| Collector-Emitter Voltage | VCES | 30 | Vdc |
| Collector-Base Voltage | V _{CBO} | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 10 | Vdc |
| Collector Current — Continuous | lc | 1.0 | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.5 20 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | °C |

MPSW13 MPSW14

CASE 29-03, STYLE 1 TO-92 (TO-226AE)

DARLINGTON TRANSISTOR

NPN SILICON

THERMAL CHARACTERISTICS

| *************************************** | | _ | |
|---|--------|-----|------|
| Characteristic | Symbol | Max | Unit |
| Thermal Resistance, Junction to Case | RøJC | 50 | °C/W |
| Thermal Resistance, Junction to Ambient | Reia | 125 | °C/W |

| Characteristic | | Symbol | Min | Max | Unit |
|---|------------------|----------------------|------------------|-----|------|
| OFF CHARACTERISTICS | | | ·/· | | |
| Collector-Emitter Breakdown Voltage (IC = 100 µAdc, VBE = 0) | | V(BR)CES | 30 | _ | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, I _E = 0) | | ІСВО | _ | 100 | nAdc |
| Emitter Cutoff Current (VEB = 10 Vdc, IC = 0) | | IEBO | _ | 100 | nAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) | MPSW13 MPSW14 | hFE | 5000 10,000 | = | _ |
| (I _C = 100 mAdc, V_{CE} = 5.0 Vdc) | MPSW13 MPSW14 | | 10,000 20,000 | _ | |
| Collector-Emitter Saturation Voltage (IC = 100 mAdc, IB = 0.1 mAdc) | | V _{CE(sat)} | _ | 1.5 | Vdc |
| Base-Emitter On Voltage (IC = 100 mAdc, VCE = 5.0 Vdc) | | V _{BE(on)} | - | 2.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product(2) (IC = 10 mAdc, VCE = 5.0 Vdc, f = 100 MHz) | | fτ | 125 | _ | MHz |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

⁽²⁾ fT = |hfe| • ftest.

FIGURE 1 — ACTIVE REGION SAFE OPERATING AREA

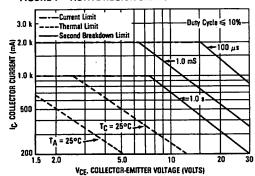
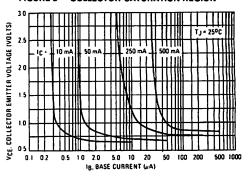


FIGURE 2 — DC CURRENT GAIN 200 100 (70 1 50 1 DC CURRENT GAIN 30 20 10 1 7.0 5.0 7.0 70 200 300 500 IC. COLLECTOR CURRENT (mA)

FIGURE 3 — COLLECTOR-SATURATION REGION



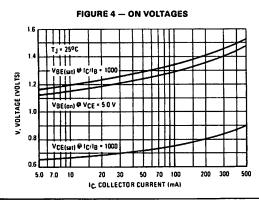
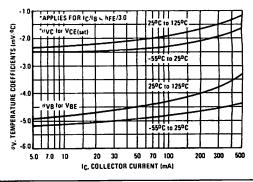
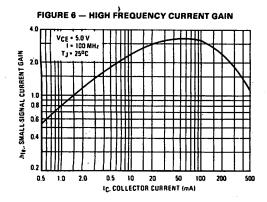
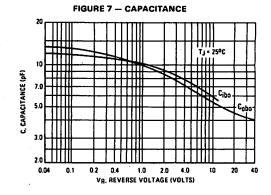


FIGURE 5 - TEMPERATURE COEFFICIENTS







MPSW42 MPSW43

CASE 29-03, STYLE 1 TO-92 (TO-226AE)

HIGH VOLTAGE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | MPSW42 | MPSW43 | Unit |
|---|-----------------------------------|------------|--------|----------------|
| Collector-Emitter Voltage | VCEO | 300 | 200 | Vdc |
| Collector-Base Voltage | VCBO | 300 | 200 | Vdc |
| Emitter-Base Voltage | VEBO | 6 | 6.0 | |
| Collector Current — Continuous | lc | 500 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.5 20 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to | + 150 | °C |

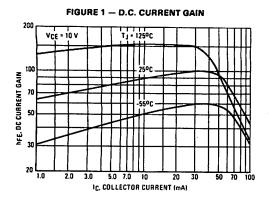
THERMAL CHARACTERISTICS

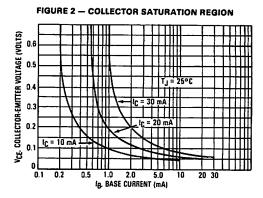
| Characteristic | Symbol | Max | Unit |
|---|-------------------|-----|------|
| Thermal Resistance, Junction to Case | ReJC | 50 | °C/W |
| Thermal Resistance, Junction to Ambient | R _Ø JA | 125 | °C/W |

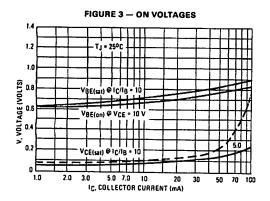
| Characteristic | | Symbol | Min | Max | Unit |
|---|--|----------------------|----------------------|-------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | MPSW42 MPSW43 | V(BR)CEO | 300 200 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μ Adc, IE = 0) | MPSW42 MPSW43 | V(BR)CBO | 300 200 | _ | Vdc |
| Emitter-Base Breakdown Voltage | | V(BR)EBO | 6.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 200 Vdc, IE = 0) (VCB = 160 Vdc, IE = 0) | MPSW42 MPSW43 | ІСВО | <u>-</u> | 0.1 0.1 | μAdc |
| Emitter Cutoff Current (VEB = 6.0 Vdc, I _C = 0) (VEB = 4.0 Vdc, I _C = 0) | MPSW42 MPSW43 | lEBO | - | 0.1 0.1 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc) (I _C = 30 mAdc, V _{CE} = 10 Vdc) | Both Types Both Types MPSW42 MPSW43 | hFE | 25 40 40 40 | - - - | _ |
| Collector-Emitter Saturation Voltage (I _C = 20 mAdc, I _B = 2.0 mAdc) | MPSW42 MPSW43 | VCE(sat) | 1 1 | 0.5 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 20 mAdc, Ig = 2.0 mAdc) | | V _{BE(sat)} | - | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 20 MHz) | | fT | 50 | | MHz |
| Collector-Base Capacitance (VCB = 20 Vdc, IE = 0, f = 1.0 MHz) | MPSW42 MPSW43 | C _{cb} | _ | 3.0 4.0 | pF |

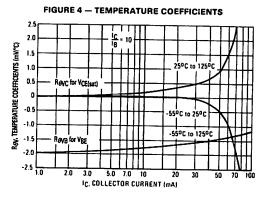
⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

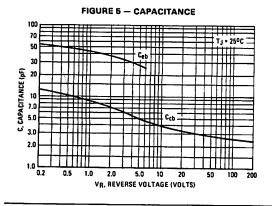
MPSW42, MPSW43











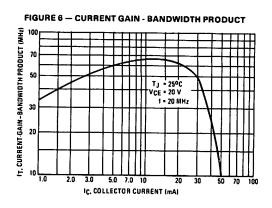
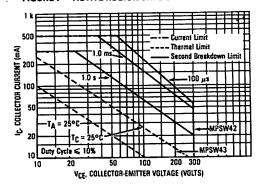


FIGURE 7 — ACTIVE REGION SAFE OPERATING AREA



| Rating | Symbol | Value | Unit |
|---|----------------------|-------------|----------------|
| Collector-Emitter Voltage | VCES | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 50 | Vdc |
| Emitter-Base Voltage | VEBO | 12 | Vdc |
| Collector Current — Continuous | lc | 1.0 | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.5 20 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|-----------------|------|------|
| Thermal Resistance, Junction to Case | R _{NC} | . 50 | °C/W |
| Thermal Resistance, Junction to Ambient | ReJA | 125 | °C/W |

MPSW45

CASE 29-03, STYLE 1 TO-92 (TO-226AE)

DARLINGTON TRANSISTOR

NPN SILICON

Refer to 2N6426 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|----------------------|---------------------------|-------------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 100 µAdc, VBE = 0) | V(BR)CES | 40 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 50 | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 12 | - | Vdc |
| Collector Cutoff Current (V _{CB} = 30 Vdc, I _E = 0) | ICBO | _ | 100 | nAdc |
| Emitter Cutoff Current (VEB = 10 Vdc, IC = 0) | ¹ EBO | | 100 | nAdc |
| ON CHARACTERISTICS(1) | | | | |
| DC Current Gain (IC = 200 mAdc, V _{CE} = 5.0 Vdc) (IC = 500 mAdc, V _{CE} = 5.0 Vdc) (IC = 1.0 Adc, V _{CE} = 5.0 Vdc) | hFE | 25,000 15,000 4,000 | 150,000 — — | _ |
| Collector-Emitter Saturation Voltage (IC = 1.0 Adc, Ig = 2.0 mAdc) | V _{CE(sat)} | | 1.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 1.0 Adc, IB = 2.0 mAdc) | V _{BE(sat)} | | 2.0 | Vdc |
| Base-Emitter On Voltage (IC = 1.0 Adc, VCE = 5.0 Vdc) | VBE(on) | _ | 2.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 200 mAdc, VCE = 5.0 Vdc, f = 100 MHz) | fτ | 100 | _ | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, Ig = 0, f = 1.0 MHz) | C _{cb} | | 6.0 | ρF |

MPSW51 MPSW51A

CASE 29-03, STYLE 1 TO-92 (TO-226AE)

HIGH CURRENT TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| MAXIMON NATINGO | | | |
|--|-----------------------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage MPSW51 MPSW51A | VCEO | 30 40 | Vdc |
| Collector-Base Voltage MPSW51 MPSW51A | VCBO | 40 50 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 1000 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.5 20 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{Stg} | -55 to +150 | °C |

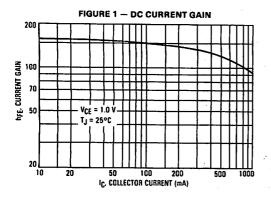
THERMAL CHARACTERISTICS

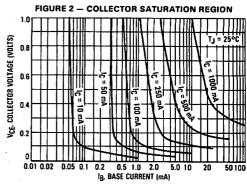
| Characteristic | Symbol | Max | Unit |
|---|------------------|-----|------|
| Thermal Resistance, Junction to Case | ReJC | 50 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 125 | °C/W |

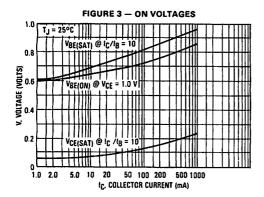
| Characteristic | | Symbol | Min | Max | Unit |
|--|-------------------|----------------------|----------------|------------|----------------|
| OFF CHARACTERISTICS | | | | | ,- |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, Ig = 0) | MPSW51 MPSW51A | V(BR)CEO | 30 40 | = | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0) | MPSW51 MPSW51A | V(BR)CBO | 40 50 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current $(V_{CB} = 30 \text{ Vdc}, I_E = 0)$ $(V_{CB} = 40 \text{ Vdc}, I_E = 0)$ | MPSW51 MPSW51A | СВО | _ | 0.1 0.1 | μAdc |
| Emitter Cutoff Current (VEB = 3.0 Vdc, I _C = 0) | | IEBO | | 0.1 | μAdc |
| ON CHARACTERISTICS(1) | | | | | , |
| DC Current Gain (IC = 10 mAdc, V _{CE} = 1.0 Vdc) (IC = 100 mAdc, V _{CE} = 1.0 Vdc) (IC = 1000 mAdc, V _{CE} = 1.0 Vdc) | | hte | 55 60 50 | |] - |
| Collector-Emitter Saturation Voltage (IC = 1000 mAdc, Ig = 100 mAdc) | | V _{CE(sat)} | _ | 0.7 | Vdc |
| Base-Emitter On Voltage (IC = 1000 mAdc, VCE = 1.0 Vdc) | | VBE(on) | _ | 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | · |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 10 Vdc, f = 20 MHz) | _ | fτ | 50 | | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz) | | C _{obo} | _ | 30 | pF |

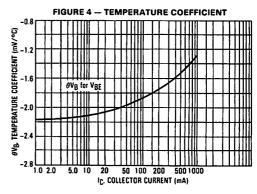
⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

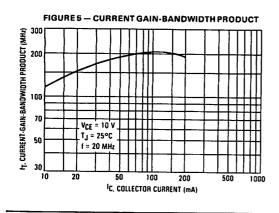
MPSW51, MPSW51A











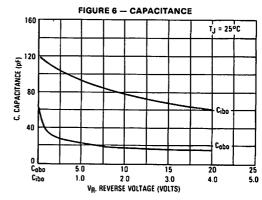
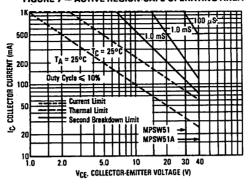


FIGURE 7 — ACTIVE REGION-SAFE OPERATING AREA



| Rating | Symbol | MPSW55 | MPSW56 | Unit |
|---|-----------------------------------|-------------|--------|----------------|
| Collector-Emitter Voltage | VCEO | 60 | 80 | Vdc |
| Collector-Base Voltage | V _{CBO} | 60 | 80 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | | Vdc |
| Collector Current — Continuous | lc | 500 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.5 20 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | | °C |

MPSW56

MPSW55

CASE 29-03, STYLE 1 TO-92 (TO-226AE) AMPLIFIER TRANSISTOR

PNP SILICON

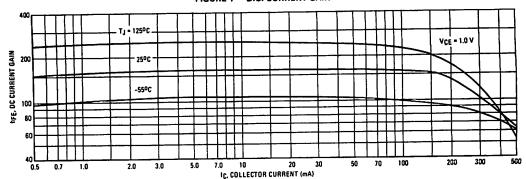
THERMAL CHARACTERISTICS

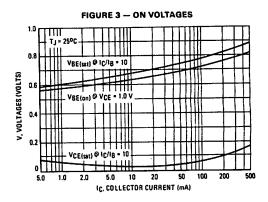
| Characteristic | Symbol | Max | Unit |
|---|--------|-----|------|
| Thermal Resistance, Junction to Case | ReJC | 50 | °C/W |
| Thermal Resistance, Junction to Ambient | ReJA | 125 | °C/W |

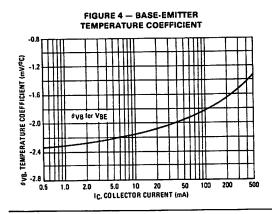
| Characteristic | | Symbol | Min | Max | Unit |
|--|------------------|-----------------------|----------|------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (I _C = 1.0 mAde, I _B = 0) | MPSW56 MPSW56 | V _(BR) CEO | 60 80 | = | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 4.0 | | Vdc |
| Collector Cutoff Current ($VCE = 40 \text{ Vdc}$, $IB = 0$) ($VCE = 60 \text{ Vdc}$, $IB = 0$) | MPSW55 MPSW56 | ICEO | _ | 0.5 0.5 | μAdc |
| Collector Cutoff Current (VCB = 40 Vdc, IE = 0) (VCB = 60 Vdc, IE = 0) | MPSW55 MPSW56 | ІСВО | _ | 0.1 0.1 | μAdc |
| Emitter Cutoff Current (VEB = 3.0 Vdc, IC = 0) | | ^I EBO | _ | 0.1 | μAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain (IC = 50 mAdc, V _{CE} = 1.0 Vdc) (IC = 250 mAdc, V _{CE} = 1.0 Vdc) | | ptE | 80 50 | _ | _ |
| Collector-Emitter Saturation Voltage (I _C = 250 mAdc, I _B = 10 mAdc) | | V _{CE(sat)} | | 0.5 | Vdc |
| Base-Emitter On Voltage (IC = 250 mAdc, VCE = 5.0 Vdc) | | V _{BE(on)} | _ | 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | L | |
| Current-Gain — Bandwidth Product (IC = 250 mAdc, VCE = 5.0 Vdc, f = 100 MHz) | | fT | 50 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, f = 1.0 MHz) | | Cobo | | 15 | pF |

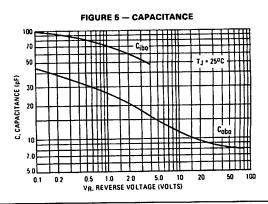
⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

FIGURE 1 - D.C. CURRENT GAIN

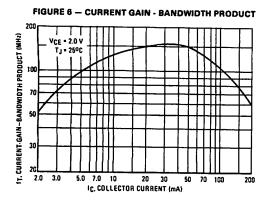








MPSW55, MPSW56



VCE. COLLECTOR-EMITTER VOLTAGE (VOLTS)

SMALL-SIGNAL DEVICES

MPSW60

CASE 29-03, STYLE 1 TO-92 (TO-226AE)

HIGH VOLTAGE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|----------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 300 | Vdc |
| Collector-Base Voltage | V _{CBO} | 300 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc · | 500 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.5 20 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|-----|------|
| Thermal Resistance, Junction to Case | RøJC | 50 | •c/w |
| Thermal Resistance, Junction to Ambient | RAIA | 125 | °C/W |

Refer to MPSW92 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|-----------------|----------------|------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 300 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 300 | | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10.0 μAdc, IC = 0) | V(BR)EBO | 5.0 | | Vdc |
| Collector Cutoff Current (V _{CB} = 200 Vdc, t _E = 0) | ІСВО | | 0.2 | μAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | IEBO | _ | 0.1 | μAdc |
| ON CHARACTERISTICS(1) | | | | |
| DC Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc) (IC = 10 mAdc, VCE = 10 Vdc) (IC = 30 mAdc, VCE = 10 Vdc) | hFE | 25 30 25 | = = | _ |
| Collector-Emitter Saturation Voltage (IC = 20 mAde, I _B = 2.0 mAde) | VCE(sat) | _ | 0.75 | Vdc |
| Base-Emitter On Voltage (IC = 20 mAdc, VCE = 10 Vdc) | VBE(on) | _ | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gein — Bandwidth Product (IC = 10 mAde, VCE = 20 Vdc, f = 20 MHz) | fΤ | 60 | - | MHz |
| Collector-Base Capacitance (V _{CB} = 20 Vdc, I _E = 0, f = 10 MHz) | C _{cb} | | 8.0 | pF |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| Rating | Symbol | MPSW63 MPSW64 | Unit |
|--|----------|------------------|----------------|
| Collector-Emitter Voltage | VCES | 30 | Vdc |
| Collector-Base Voltage | VCBO | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 10 | Vdc |
| Collector Current — Continuous | lc | 500 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/℃ |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.5 20 | Watts mW/°C |
| Operating and Storage Junction | TJ, Tstg | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|-----|------|
| Thermal Resistance, Junction to Case | RAJC | 50 | °C/W |
| Thermal Resistance, Junction to Ambient | Raja | 125 | •cw |

MPSW63 MPSW64

CASE 29-03, STYLE 1 TO-92 (TO-226AE)

DARLINGTON TRANSISTOR

PNP SILICON

| Characteristic | | Symbol | Min | Max | Unit |
|---|------------------|---------------------|------------------|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 100 µAdc, VBE = 0) | | V(BR)CES | 30 | | Vdc |
| Collector Cutoff Current (V _{CB} = 30 Vdc, I _E = 0) | | ГСВО | _ | 100 | nAdc |
| Emitter Cutoff Current (VEB = 10 Vdc, IC = 0) | | IEBO | ı | 100 | nAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gein (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) | MPSW63 MPSW64 | hFE | 5,000 10,000 | = | _ |
| (IC = 100 mAdc, VCE = 5.0 Vdc) | MPSW63 MPSW64 | | 10,000 20,000 | | |
| Collector-Emitter Saturation Voltage (IC = 100 mAdc, IB = 0.1 mAdc) | | VCE(sat) | ı | 1.5 | Vdc |
| Base-Emitter On Voltage (I _C = 100 mAdc, V _{CE} = 5.0 Vdc) | | V _{BE(on)} | _ | 2.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product(2) (IC = 10 mAdc, VCE = 5.0 Vdc, f = 100 MHz) | | fr | 125 | _ | MHz |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

⁽²⁾ fT = |hfe| • ftest.

TYPICAL ELECTRICAL CHARACTERISTICS



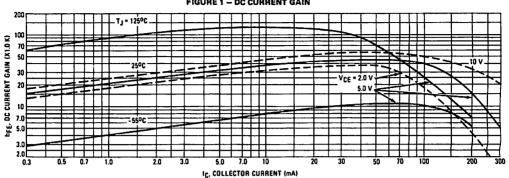


FIGURE 2 - "ON" VOLTAGE

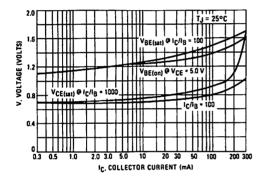


FIGURE 3 - COLLECTOR SATURATION REGION

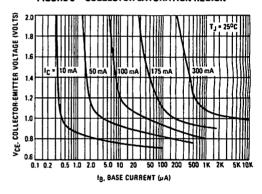


FIGURE 4 - TEMPERATURE COEFFICIENTS

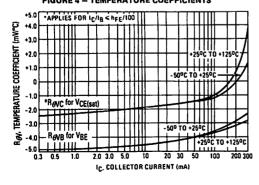
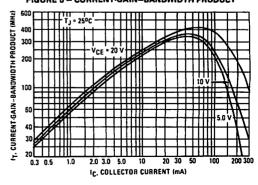
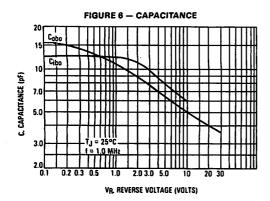
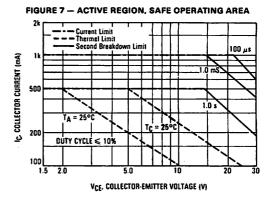


FIGURE 5 - CURRENT-GAIN-BANDWIDTH PRODUCT



MPSW63, MPSW64





MPSW92 MPSW93

CASE 29-03, STYLE 1 TO-92 (TO-226AE)

HIGH VOLTAGE TRANSISTOR

PNP SILICON

· MAXIMUM RATINGS

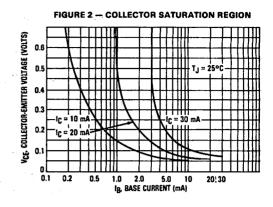
| Rating | Symbol | MPSW92 | MPSW93 | Unit |
|---|-----------------------------------|------------|---------|----------------|
| Collector-Emitter Voltage | VCEO | 300 | 200 | Vdc |
| Collector-Base Voltage | V _{CBO} | 300 | 200 | Vdc |
| Emitter-Base Voltage | VEBO | 5 | .0 | Vdc |
| Collector Current — Continuous | lc | 500 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | | .5 0 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to | + 150 | °C |

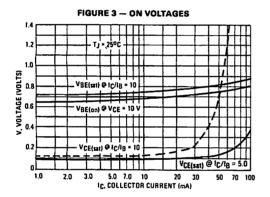
THERMAL CHARACTERISTICS

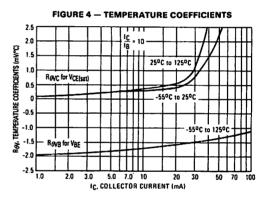
| Characteristic | Symbol | Max | Unit |
|---|--------|-----|------|
| Thermal Resistance, Junction to Case | RøJC | 50 | °C⁄W |
| Thermal Resistance, Junction to Ambient | ReJA | 125 | °C⁄W |

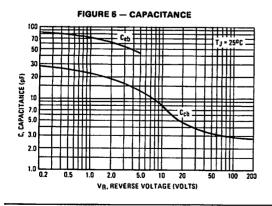
| Characteristic | | Symbol | Min | Max | Unit |
|---|--|----------------------|----------------------|------------------|------|
| OFF CHARACTERISTICS | | • | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | MPSW92 MPSW93 | V(BR)CEO | 300 200 | = | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μ Adc, IE = 0) | MPSW92 MPSW93 | V(BR)CBO | 300 200 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | - | Vdc |
| Collector Cutoff Current (VCB = 200 Vdc, $IE = 0$) (VCB = 160 Vdc, $IE = 0$) | MPSW92 MPSW93 | ІСВО | = | 0.25 0.25 | μAdc |
| Emitter Cutoff Current (VEB = 3.0 Vdc, I _C = 0) | | IEBO | _ | 0.1 | μAdc |
| ON CHARACTERISTICS(1) | | | | | - |
| DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc) (I _C = 30 mAdc, V _{CE} = 10 Vdc) | Both Types Both Types MPSW92 MPSW93 | hFE | 25 40 25 25 | _ _ _ _ | _ |
| Collector-Emitter Saturation Voltage (I _C = 20 mAdc, I _B = 2.0 mAdc) | MPSW92 MPSW93 | VCE(sat) | | 0.5 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 20 mAdc, Ig = 2.0 mAdc) | | V _{BE(sat)} | - | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 20 MHz) | | fT | 50 | _ | MHz |
| Collector-Base Capacitance (VCB = 20 Vdc, I _E = 0, f = 1.0 MHz) | MPSW92 MPSW93 | C _{cb} | _ | 6.0 8.0 | pF |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.









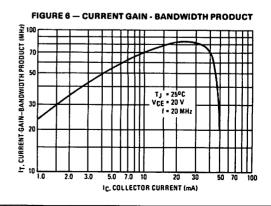
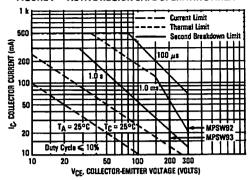


FIGURE 7 — ACTIVE REGION SAFE OPERATING AREA



MSD6100

CASE 29-02, STYLE 3 TO-92 (TO-226AA)

DUAL SWITCHING DIODE COMMON CATHODE

MAXIMUM RATINGS

| 100 0 10 10 10 10 10 10 10 10 10 10 10 1 | | | |
|--|---------------------------------------|-------------|-------------|
| Rating | Symbol | Value | Unit |
| Reverse Voltage | V _R | 100 | Vdc |
| Recurrent Peak Forward Current | lF | 200 | mA |
| Peak Forward Surge Current (Pulse Width = 10 μsec) | FM(surge) | 500 | mA |
| Power Dissipation @ T _A = 25°C Derate above 25°C | P _D (1) | 625 5.0 | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} (1) | -55 to +135 | .€ |

| Characteristic | Symbol | Min | Max | Unit |
|---|-------------------|----------------------|--------------------|------|
| Breakdown Voltage (I(BR) = 100 µAdc) | V _(BR) | 100 | _ | Vdc |
| Reverse Current (V _R = 100 Vdc) (V _R = 50 Vdc) (V _R = 50 Vdc, T _A = 125°C) | IR | - | 5.0 0.1 20 | μAdc |
| Forward Voltage (IF = 1.0 mAdc) (IF = 10 mAdc) (IF = 100 mAdc) | VF | 0.55 0.67 0.75 | 0.7 0.82 1.1 | Vdc |
| Capacitance (V _R = 0) | С | - | 1.5 | pF |
| Reverse Recovery Time {IF = IR = 10 mAdc, V _R = 5.0 Vdc, i _{rr} = 1.0 mAdc) | t _{rr} | _ | 4.0 | ns |

⁽¹⁾ Continuous package improvements have enhanced these guaranteed Maximum Ratings as follows: PD = 1.0 W @ TC = 25°C, Derate above 25°C — 8.0 mW/°C, TJ = -65 to +150°C, &JC = 125°C/W.

MSD6102

CASE 29-02, STYLE 3 TO-92 (TO-226AA)

DUAL DIODE COMMON CATHODE

MAXIMUM RATINGS

| | | Mala | 1114 |
|--|---------------------------------------|-------------|-------------|
| Rating | Symbol | Value | Unit |
| Reverse Voltage | v _R | 70 | Vdc |
| Recurrent Peak Forward Current | lF | 200 | mA |
| Peak Forward Surge Current (Pulse Width = 10 μs) | IFM(surge) | 500 | mA |
| Power Dissipation @ T _A = 25°C Derate above 25°C | P _D (1) | 625 5.0 | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} (1) | -55 to +135 | °C |

⁽¹⁾ Continuous package improvements have enhanced these guaranteed Maximum Ratings as follows: P_D = 1.0 W @ T_C = 25°C, Derate above 25°C — 8.0 mW/°C, T_J = -65 to +150°C, &JC = 125°C/W.

| Characteristic | Symbol | Min | Max | Unit |
|--|-------------------|-----|-----|------|
| Breakdown Voltage (I(BR) = 100 µAdc) | V _(BR) | 70 | _ | Vdc |
| Reverse Current (VR = 50 Vdc) | I _R | | 0.1 | μAdc |
| Forward Voltage (I _F = 10 mAdc) | V _F | _ | 1.0 | Vdc |
| Capacitance (Vp = 0) | С | _ | 3.0 | pF |
| Reverse Recovery Time (I _F = I _R = 10 mAdc, V _R = 5.0 Vdc, i _{rr} = 1.0 mAdc) | t _{rr} | _ | 100 | ns |

MSD6150

CASE 29-02, STYLE 4 TO-92 (TO-226AA)

DUAL DIODE COMMON ANODE

MAXIMUM RATINGS

| NDOWNON IDATING | | | |
|---|---------------------------------------|-------------|------------|
| Rating | Symbol | Value | Unit |
| Reverse Voltage | V _R | 70 | Vdc |
| Peak Forward Recurrent Current | ΙF | 200 | mA |
| Peak Forward Surge Current (Pulse Width = 10 μs) | FM(surge) | 500 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | P _D (1) | 625 5.0 | mW mW°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} (1) | -55 to +135 | °C |

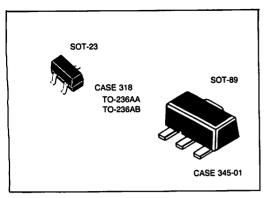
| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|-------------------|-----|------|-----|------|
| Breakdown Voltage (I _(BR) = 100 µAdc) | V _(BR) | 70 | _ | _ | Vdc |
| Reverse Current (V _R = 50 Vdc) | IR | _ | - | 0.1 | μAdc |
| Forward Voltage (Ip = 10 mAdc) | VF | _ | 0.80 | 1.0 | Vdc |
| Capacitance (V _R = 0) | С | _ | 5.0 | 8.0 | pF |
| Reverse Recovery Time (I _F = I _R = 10 mAdc, V _R = 5.0 Vdc, i _{rr} = 1.0 mAdc) | t _{rr} | | _ | 100 | ns |

⁽¹⁾ Continuous package improvements have enhanced these guaranteed Maximum Ratings as follows: PD = 1.0 W @ TC = 25°C, Derate above 8.0 mW/°C, PD = 10 W @ TC = 25°C, Derate above 80 mW/°C, TJ, Tstg = -55 to +150°, &UC = 12.5°C/W, &JA = 125°C.

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- · reverse pinout
- standard profile (TO-236AA) or low profile (TO-236AB)

Contact your Motorola representative for ordering information.

Microminature Products

BAL99

CASE 318-02/03, STYLE 17 SOT-23 (TO-236AA/AB)

SWITCHING DIODE

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|----------------------------|--------|-------|------|
| Continuous Reverse Voltage | VR | 70 | Vdc |
| Peak Forward Current | IF. | 100 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | •€ |
| *Thermal Resistance Junction to Ambient | ReJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | Symbol | Min | Max | Unit |
|--|-------------------|-------------|----------------------------|------|
| OFF CHARACTERISTICS | | | | |
| Reverse Voltage Leakage Current (V _R = 70 V) (V _R = 25 V, T _J = 150°C) (V _R = 70 V, T _J = 150°C) | IR | 111 | 2.5 30 50 | μΑ |
| Reverse Breakdown Voltage (IR = 100 µA) | V _(BR) | 70 | - | ٧ |
| Forward Voltage (IF = 1.0 mA) (IF = 10 mA) (IF = 50 mA) (IF = 100 mA) | VF | - - - | 715 855 1100 1300 | mV |
| Recovery Current (IF = 10 mA, VR = 5.0 V, RL = 500 Ω) | QS | _ | 45 | рС |
| Diode Capacitance (V _R = 0, f = 1.0 MHz) | C _D | _ | 1.5 | pF |
| Reverse Recovery Time $\{l_F=l_R=10\text{ mA},R_L=100\Omega,\text{measured at }l_R=1.0\text{mA}\}$ | t _{rr} | _ | 6.0 | ns |
| Forward Recovery Voltage (IF = 10 mA, t _r = 20 ns) | VFR | _ | 1.75 | V |

| Rating | Symbol | Value | Unit |
|----------------------------|----------------|-------|------|
| Continuous Reverse Voltage | V _R | 75 | Vcc |
| Peak Forward Current | lF | 200 | mA |
| Peak Forward Surge Current | IFM(surge) | 500 | mA |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C. |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

BAS16

CASE 318-02/03, STYLE 8 SQT-23 (TO-236AA/AB) SWITCHING DIODE

| Characteristic | Symbol | Min | Max | Unit |
|--|-----------------|-----|----------------------------|------|
| OFF CHARACTERISTICS | | | • | |
| Reverse Voltage Leakage Current (V _R = 75 V) (V _R = 75 V, T _J = 150°C) (V _R = 25 V, T _J = 150°C) | I _R | | 1.0 50 30 | μА |
| Reverse Breakdown Voltage (IBR = 100 µA) | V(BR) | 75 | | ٧ |
| Forward Voltage (F = 1.0 mA) (F = 10 mA) (F = 50 mA) (F = 100 mA) | V _F | | 715 855 1100 1300 | mV |
| Diode Capacitance (V _R = 0, f = 1.0 MHz) | C _D | _ | 2.0 | pF |
| Forward Recovery Voltage (I _F = 10 mA, t _r = 20 ns) | V _{FR} | _ | 1.75 | ٧ |
| Reverse Recovery Time (IF = IR = 10 mA, RL = 100 Ω) | t _{rr} | _ | 6.0 | ns |
| Stored Charge (IF = 10 mA to VR = 5.0 V, RL = 500 Ω) | QS | - | 45 | рC |

BAV70

CASE 318-02/03, STYLE 9 SOT-23 (TO-236AA/AB)

SWITCHING DIODE

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|----------------------------|------------------------|-------|------|
| Reverse Voltage | V _R | 70 | Vdc |
| Forward Current | lt | 200 | mAdc |
| Peak Forward Surge Current | [†] FM(surge) | 500 | mAdc |

THERMAL CHARACTERISTICS

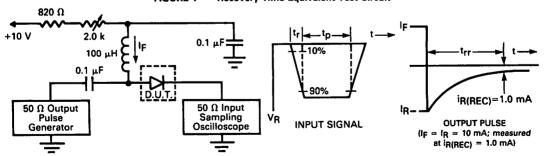
| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | ReJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|--|-------------------|-------------|----------------------------|------|
| OFF CHARACTERISTICS | | | | |
| Reverse Breakdown Voltage (I _(BR) = 100 µAdc) | V _(BR) | >70 | _ | Vdc |
| Reverse Voltage Leakage Current (V _R = 25 Vdc, T _J = 150°C) (V _R = 70 Vdc) (V _R = 70 Vdc, T _J = 150°C) | I _R | = | 60 5.0 100 | μAdc |
| Diode Capacitance (V _R = 0, f = 1.0 MHz) | СT | _ | 1.5 | pF |
| Forward Voltage (IF = 1.0 mAdc) (IF = 10 mAdc) (IF = 50 mAdc) (IF = 100 mAdc) | V _F | _ _ _ | 715 855 1100 1300 | mVdc |
| Reverse Recovery Time $(I_F = I_R = 10 \text{ mAdc}, V_R = 5.0 \text{ Vdc},$ $I_R(REC) = 1.0 \text{ mAdc})$ (Figure 1) | t _{rr} | - | 6.0 | ns |

FIGURE 1 — Recovery Time Equivalent Test Circuit



Notes: 1. A 2.0 k Ω variable resistor adjusted for a Forward Current (IF) of 10 mA.

- 2. Input pulse is adjusted so IR(peak) is equal to 10 mA.
- 3. tp = trr

| Rating | Symbol | Value | Unit |
|----------------------------|----------------|-------|------|
| Reverse Voltage | V _R | 50 | Vdc |
| Forward Current | ΙF | 200 | mAdc |
| Peak Forward Surge Current | !FM(surge) | 500 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | Raja | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

BAV74

CASE 318-02/03, STYLE 9 SOT-23 (TO-236AA/AB) SWITCHING DIODE

| Characteristic | Symbol | Min | Max | Unit |
|---|-------------------|-----|------------|------|
| OFF CHARACTERISTICS | | | | |
| Reverse Breakdown Voltage (I(BR) = 5.0 μAdc) | V _(BR) | 50 | _ | Vdc |
| Reverse Voltage Leakage Current (V _R = 50 Vdc, T _J = 125°C) (V _R = 50 Vdc) | IR | | 100 0.1 | μAdc |
| Diode Capacitance (V _R = 0, f = 1.0 MHz) | СТ | 1 | 2.0 | pF |
| Forward Voltage (IF = 100 mAdc) | VF | | 1.0 | Vdc |
| Reverse Recovery Time (IF = IR = 10 mAdc, iR(REC) = 1.0 mAdc, measured at IR = 1.0 mA, R_L = 100 Ω) | t _{rr} | _ | 4.0 | ns |

BAV99

CASE 318-02/03, STYLE 11 SOT-23 (TO-236AA/AB)

DUAL SERIES
SWITCHING DIODE

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|----------------------------|------------|-------|------|
| Reverse Voltage | VR | 70 | Vdc |
| Forward Current | ļŧ | 100 | mAdc |
| Peak Forward Surge Current | IFM(surge) | 500 | mAdc |

THERMAL CHARACTERISTICS

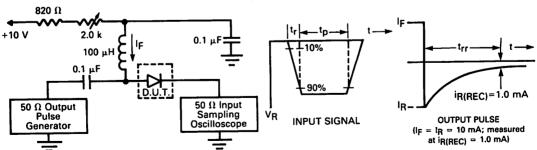
| THE HIDE OF THE TELESTICS | | | |
|---|------------------|------------|-------------|
| Characteristic | Symbol | Max | Unit |
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | Raja | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|---|--------|------------------|----------------------------|------|
| OFF CHARACTERISTICS | | | | |
| Reverse Breakdown Voltage (I(BR) = 100 μA) | V(BR) | 70 | | Vđc |
| Reverse Voltage Leakage Current (VR = 25 Vdc, TJ = 150°C) (VR = 70 Vdc) (VR = 70 Vdc, TJ = 150°C) | l R | = | 30 2.5 50 | μAdc |
| Diode Capacitance (V _R = 0, f = 1.0 MHz) | Ст | | 1.5 | pF |
| Forward Voltage (IF = 1.0 mAdc) (IF = 10 mAdc) (IF = 50 mAdc) (IF = 100 mAdc) | VF | _ _ _ _ | 715 855 1100 1300 | mVdc |
| Reverse Recovery Time (IF = IR = 10 mAdc, IR(REC) = 1.0 mAdc) (Figure 1) | trr | | 6.0 | пз |

FIGURE 1 — Recovery Time Equivalent Test Circuit



Notes: 1. A 2.0 k Ω variable resistor adjusted for a Forward Current (IF) of 10 mA.

2. Input pulse is adjusted so IR(peak) is equal to 10 mA.

3. to * trr

| Rating | Symbol | Value | Unit |
|----------------------------|----------------|-------|------|
| Reverse Voltage | V _R | 70 | Vdc |
| Forward Current | ΙF | 200 | mAdc |
| Peak Forward Surge Current | IFM(surge) | 200 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | RAJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

BAW56

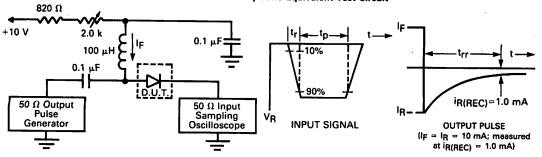
CASE 318-02/03, STYLE 12 SOT-23 (TO-236AA/AB)

DUAL SWITCHING DIODE

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------|-----------------------------|----------------------------|------|
| OFF CHARACTERISTICS | | - | <u> </u> | |
| Reverse Breakdown Voltage (I _(BR) = 100 µAdc) | V(BR) | 70 | _ | Vdc |
| Reverse Voltage Leakage Current (V _R = 25 Vdc, T _J = 150°C) (V _R = 70 Vdc) (V _R = 70 Vdc, T _J = 150°C) | l _R | <u>-</u> | 30 2.5 50 | μAdc |
| Diode Capacitance (V _R = 0, f = 1.0 MHz) | c _T | _ | 2.5 | pF |
| Forward Voltage (IF = 1.0 mAdc) (IF = 10 mAdc) (IF = 50 mAdc) (IF = 100 mAdc) | VF | - - - - | 715 855 1100 1300 | mVdc |
| Reverse Recovery Time (IF = I _R = 10 mAdc, I _{R(REC)} = 1.0 mAdc) (Figure 1) | ter | - | 6.0 | ns |

FIGURE 1 — Recovery Time Equivalent Test Circuit



Notes: 1. A 2.0 k Ω variable resistor adjusted for a Forward Current (IF) of 10 mA.

2. Input pulse is adjusted so IR(peak) is equal to 10 mA.

3. tp = tm

BCW29,30

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|--------|-------|------|
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Base Voltage | VCBO | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 100 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | ReJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

Refer to 2N5086 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|----------------|---------------------------------------|------------|------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 2.0 mAdc, IE = 0) | | V(BR)CEO | 20 | - | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 100 μAdc, VEB = 0) | | V(BR)CES | 30 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IC = 0) | | V(BR)CBO | 30 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 20 Vdc, I _E = 0) (V _{CB} = 20 Vdc, I _E = 0, T _A = 100°C) | | ІСВО | _ | 100 10 | nAdc μAdc |
| ON CHARACTERISTICS | | | | y- · | |
| DC Current Gain (I _C = 2.0 mAdc, V _{CE} = 5.0 Vdc) | BCW29 BCW30 | pŁE | 120 215 | 260 500 | =_ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 0.5 mAdc) | | VCE(sat) | _ | 0.3 | Vdc |
| Base-Emitter On Voltage (IC = 2.0 mAdc, VCE = 5.0 Vdc) | | VBE(on) | 0.6 | 0.75 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | · · · · · · · · · · · · · · · · · · · | | | |
| Output Capacitance (Ig = 0, VCE = 10 Vdc, f = 1.0 MHz) | <u> </u> | C _{obo} | _ | 7.0 | pF |
| Noise Figure (I _C = 0.2 mAdc, V _{CE} = 5.0 Vdc, R _S = 2.0 k Ω , f = 1.0 kHz, BW = 200 Hz) | | NF | _ | 10 | dB |

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Base Voltage | V _{CBO} | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 100 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | Tstg | 150 | °c |
| *Thermal Resistance Junction to Ambient | R _{BJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

BCW31,32,33

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to MPS3904 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|-------------------------|----------------------|-------------------|-------------------|-------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 2.0 mAdc, Ig = 0) | | V(BR)CEO | 20 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IB = 0) | | V(BR)CBO | 30 | | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 2.0 mAdc, V _{CE} = 5.0 Vdc) | BCW31 BCW32 BCW33 | hFE | 110 200 420 | 220 450 800 | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 0.5 mAdc) | . | V _{CE(sat)} | ,- | 0.25 | Vdc |
| Base-Emitter On Voltage (IC = 2.0 mAdc, VCE = 5.0 Vdc) | - ' . | VBE(on) | 0.55 | 0.70 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | • | |
| Output Capacitance (I _E = 0, V _{CB} = 10 Vdc, f = 1.0 MHz) | | C _{obo} | _ | 4.0 | pF |
| Noise Figure (I _C = 0.2 mAdc, V_{CE} = 5.0 Vdc, R_S = 2.0 k Ω , f = 1.0 kHz, BW = 200 Hz) | | NF | _ | 10 | dB |

BCW60A,B,C,D

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 32 | Vdc |
| Collector-Base Voltage | V _{CBO} | 32 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lс | 100 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | ~ |
| *Thermal Resistance Junction to Ambient | RAJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

Refer to MPS3904 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------------------------|---------------------|--------------------------|--------------------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 2.0 mAdc, IE = 0) | | V(BR)CEO | 32 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 1.0 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 32 Vdc) (VCF = 32 Vdc, TA = 150°C) | | ICES | = | 20 20 | nAdc μAdc |
| Emitter Cutoff Current (VEB = 4.0 Vdc, IC = 0) | | [†] EBO | - | 20 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 10 μAdc, VCE = 5.0 Vdc) | BCW60A BCW60B BCW60C BCW60D | μŁΕ | 20 40 100 | _ _ _ _ | - |
| (I _C = 2.0 mAdc, V _{CE} = 5.0 Vdc) | BCW60A BCW60B BCW60C BCW60D | | 120 180 250 380 | 220 310 460 630 | |
| (I _C = 50 mAdc, V _{CE} = 1.0 Vdc) | BCW60A BCW60B BCW60C BCW60D | | 60 70 90 100 | = | |
| (I _C = 2.0 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 kHz) | BCW60A BCW60B BCW60C BCW60D | | 125 175 250 350 | 250 350 500 700 | |
| Collector-Emitter Saturation Voltage (IC = 50 mAdc, Ig = 1.25 mAdc) (IC = 10 mAdc, Ig = 0.25 mAdc) | - | VCE(sat) | _ | 0.55 0.35 | Vdc |
| Base-Emitter Saturation Voltage (IC = 50 mAdc, Ig = 1.25 mAdc) (IC = 50 mAdc, Ig = 0.25 mAdc) | | VBE(sat) | 0.7 0.6 | 1.05 0.85 | Vdc |
| Base-Emitter On Voltage (IC = 2.0 mAdc, VCE = 5.0 Vdc) | | V _{BE(on)} | 0.55 | 0.75 | Vdc |

| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|-----|-------------|------|
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 5.0 Vdc, f = 1.0 MHz) | fτ | 125 | - | MHz |
| Output Capacitance (V _{CE} = 10 Vdc, I _C = 0, f = 1.0 MHz) | C _{obo} | _ | 4.5 | pF |
| Noise Figure (I _C = 0.2 mAdc, V_{CE} = 5.0 Vdc, R_S = 2.0 k Ω , f = 1.0 kHz, BW = 200 Hz) | NF | | 6.0 | dB |
| SWITCHING CHARACTERISTICS | | | <u> </u> | |
| Turn-On Time (I _C = 10 mAdc, I _{B1} = 1.0 mAdc) | ton | _ | 150 | ns |
| Turn-Off Time (IB2 = 1.0 mAdc, VBB = 3.6 Vdc, R1 = R2 = 5.0 k Ω , RL = 990 Ω) | ^t off | | 800 | กร |

BCW61A,B,C,D

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|--------|-------|------|
| Collector-Emitter Voltage | VCEO | 32 | Vdc |
| Collector-Base Voltage | VCBO | 32 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 100 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | ဗ |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

Refer to 2N5086 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------------------------|----------|--------------------------|--------------------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 2.0 mAdc, Ig = 0) | | V(BR)CEO | 32 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 1.0 µAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 32 Vdc) (VCE = 32 Vdc, TA = 150°C) | | ICES | _ | 20 20 | nAdc μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 10 μAdc, V _{CE} = 5.0 Vdc) | BCW61A BCW61B BCW61C BCW61D | hFE | 20 40 100 | - - - | _ |
| (I _C = 2.0 mAdc, V _{CE} = 5.0 Vdc) | BCW61A BCW61B BCW61C BCW61D | | 120 140 250 380 | 220 310 460 630 | } |
| (IC = 50 mAdc, V _{CE} = 1.0 Vdc) | BCW61A BCW61B BCW61C BCW61D | | 60 80 100 100 | _ _ _ | |
| (IC = 2.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | BCW61A BCW61B BCW61C BCW61D | | 125 175 250 350 | 250 350 500 700 | |
| Collector-Emitter Saturation Voltage (I _C = 50 mAdc, I _B = 1.25 mAdc) (I _C = 10 mAdc, I _B = 0.25 mAdc) | | VCE(sat) | - | 0.55 0.25 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 50 mAdc, I _B = 1.25 mAdc) (I _C = 10 mAdc, I _B = 0.25 mAdc) | | VBE(sat) | 0.68 0.6 | 1.05 0.85 | Vdc |
| Base-Emitter On Voltage (IC = 2.0 mAdc, VCE = 5.0 Vdc) | | VBE(on) | 0.6 | 0.75 | Vdc |

BCW61A,B,C,D

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|--|--------|-----|--------|------|
| SMALL SIGNAL CHARACTERISTICS | 1 - 7 | | 171.42 | Oint |
| Output Capacitance (VCE = 10 Vdc, IC = 0, f = 1.0 MHz) | Cobo | _ | 6.0 | pF |
| Noise Figure (IC = 0.2 mAdc, VCE = 5.0 Vdc, RS = 2.0 k Ω , f = 1.0 kHz, BW = 200 Hz) | NF | _ | 6.0 | dB |
| SWITCHING CHARACTERISTICS | | | | |
| Turn-On Time (IC = 10 mAdc, Ig1 = 1.0 mAdc) | ton | _ | 150 | ns |
| Turn-Off Time (Ig ₂ = 1.0 mAdc, V_{BB} = 3.6 Vdc, R_1 = R_2 = 5.0 k Ω , R_L = 990 Ω) | toff | _ | 800 | ns |

BCW65A

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

Characteristic

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|--------|-------|------|
| Collector-Emitter Voltage | VCEO | 32 | Vdc |
| Collector-Base Voltage | VCBO | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 800 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|--|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | Raja | 357 | °C/W |

Min

Тур

Max

Symbol

| OFF CHARACTERISTICS | V(BR)CEO | 32 | _ | _ | Vdc |
|--|-----------|-----|---|----------|--------------|
| Collector-Emitter Breakdown Voltage (IC = 10 mAdc, Ig = 0) | · (BR/CEO | | | | |
| Collector-Emitter Breakdown Voltage (IC = 10 µAdc, VEB = 0) | V(BR)CES | 60 | _ | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCE = 32 Vdc, IE = 0) (VCE = 32 Vdc, IE = 0, TA = 150°C) | ICES | 1 - | | 20 20 | nAdc µAdc |
| Emitter Cutoff Current (VEB = 4.0 Vdc, IC = 0) | IEBO | _ | _ | 20 | nAdc |
| ON CHARACTERISTICS | | | | | |
| | l boo | ì | 1 | | _ |

| DC Current Gain (IC = 100 µAdc, VCE = 10 Vdc) (IC = 10 mAdc, VCE = 1.0 Vdc) (IC = 100 mAdc, VCE = 1.0 Vdc) (IC = 500 mAdc, VCE = 2.0 Vdc) | nfe | 35 75 100 35 | _ _ _ | 220 250 | | |
|---|----------------------|-----------------------|-------------|--------------------|-----|--|
| Collector-Emitter Saturation Voltage (IC = 500 mAdc, Ig = 50 mAdc) (IC = 100 mAdc, Ig = 10 mAdc) | VCE(sat) | | 0.7 0.3 | | Vdc | |
| Base-Emitter Saturation Voltage (Ic = 500 mAdc, Ig = 50 mAdc) | V _{BE(sat)} | _ | _ | 2.0 | Vdc | |

SMALL-SIGNAL CHARACTERISTICS

| Current-Gain — Bandwidth Product (IC = 20 mAdc, VCE = 10 Vdc, f = 100 MHz) | ft | 100 | | _ | MHz |
|--|------------------|----------|----------|----|-----|
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | | <u> </u> | 12 | pF |
| Input Capacitance (VEB = 0.5 Vdc, IC = 0, f = 1.0 MHz) | C _{ibo} | <u> </u> | _ | 80 | pF |
| Noise Figure (I _C = 0.2 mAdc, V _{CE} = 5.0 Vdc, R _S = 1.0 kΩ, f = 1.0 kHz, BW = 200 Hz) | NF | _ | _ | 10 | dB |

SWITCHING CHARACTERISTICS

| Turn-On Time | t _{on} | _ | _ | 100 | ns |
|---|-----------------|---|---|-----|----|
| (I _{B1} = I _{B2} = 15 mAdc) Turn-Off Time | toff | _ | _ | 400 | ns |
| (to = 150 mAdc, Rt = 150 Ω) | | | | | |

Unit

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 45 | Vdc |
| Collector-Base Voltage | V _{CBO} | 75 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc lc | 800 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | •€ |
| *Thermal Resistance Junction to Ambient | RAJA | 357 | °C/W |

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic

BCW66F

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

Тур

Max

| OFF CHARACTERISTICS | | | 4 | | |
|--|----------------------|-----------------------|-------------|-------------|--------------|
| Collector-Emitter Breakdown Voltage | V(BR)CEO | 45 | | | Vdc |
| (IC = 10 mAdc, IB = 0) | - (BN/CEO | | - | | Vac |
| Collector-Emitter Breakdown Voltage (IC = 10 µAdc, VEB = 0) | V(BR)CES | 75 | | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | V(BR)EBO | 5.0 | - | - | Vdc |
| Collector Cutoff Current ($V_{CE} = 45 \text{ Vdc}$, $I_{C} = 0$) ($V_{CE} = 45 \text{ Vdc}$, $I_{C} = 0$, $T_{A} = 150^{\circ}\text{C}$) | ICES | _ | _ | 20 20 | nAdc µAdc |
| Emitter Cutoff Current (VEB = 4.0 Vdc, I _C = 0) | IEBO | _ | | 20 | nAdc |
| ON CHARACTERISTICS | | | | <u> </u> | |
| DC Current Gain (IC = 100 µAdc, V _{CE} = 1.0 Vdc) (IC = 10 mAdc, V _{CE} = 1.0 Vdc) (IC = 100 mAdc, V _{CE} = 1.0 Vdc) (IC = 500 mAdc, V _{CE} = 2.0 Vdc) | hFE | 35 75 100 35 | _ | 250 | _ |
| Collector-Emitter Saturation Voltage (I _C = 500 mAdc, I _B = 50 mAdc) (I _C = 100 mAdc, I _B = 10 mAdc) | VCE(sat) | = | 0.7 0.3 | | Vdc |
| Base-Emitter Saturation Voltage (IC = 500 mAdc, IB = 50 mAdc) | V _{BE(sat)} | _ | _ | 2.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | l | | |
| Current-Gain — Bendwidth Product (IC = 20 mAdc, VCE = 10 Vdc, f = 100 MHz) | ţΤ | 100 | _ | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | C _{obo} | _ | _ | 12 | pF |
| Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | C _{ibo} | _ | _ | 80 | pF |
| Noise Figure (IC = 0.2 mAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 k Ω , f = 1.0 kHz, BW = 200 Hz) | NF | _ | _ | 10 | dB |
| SWITCHING CHARACTERISTICS | | | | | |
| Turn-On Time (lB1 = lB2 = 15 mAdc) | t _{on} | - | - | 100 | ns |

Symbol

Min

(IC = 150 mAdc, RL = 150 Ω)

Turn-Off Time

ns

toff

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

BCW67,A,B,C BCW68,F,G

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | BCW67 | BCW68 | Unit |
|--------------------------------|------------------|-------|-------|------|
| Collector-Emitter Voltage | VCEO | 32 | 45 | Vdc |
| Collector-Base Voltage | V _{CBO} | 45 | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 5 | .0 | Vdc |
| Collector Current — Continuous | lc_ | 8 | 00 | mAdc |

THERMAL CHARACTERISTICS

| I LEVIANT CHAUSCI EURO 1100 | | | |
|---|------------------|------------|------------|
| Characteristic | Symbol | Max | Unit |
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW/°C |
| Storage Temperature | T _{stg} | 150 | ° C |
| *Thermal Resistance Junction to Ambient | ROJA | 357 | •c/w |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristi | c | Symbol | Min | Тур | Max | Unit |
|--|--|----------------------|-------------------|-----------------|-------------------|--------------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 10 mAdc, IB = 0) | BCW67 Series BCW68 Series | V(BR)CEO | 32 45 | | _ _ | Vdc |
| Collector-Emitter Breakdown Voltage (I _C = 10 μAdc, V _{EB} = 0) | BCW67 Series BCW68 Series | V(BR)CES | 45 60 | | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | | | Vdc |
| Collector Cutoff Current (VCE = 32 Vdc, IE = 0) (VCE = 45 Vdc, IE = 0) (VCE = 32 Vdc, IB = 0, TA = 150°C) (VCE = 45 Vdc, IB = 0, TA = 150°C) | BCW67 Series BCW68 Series BCW67 Series BCW68 Series | ICES | _ _ _ | | 20 20 10 | nAdc μAdc |
| Emitter Cutoff Current (VEB = 4.0 Vdc, IC = 0) | | IEBO | | _ | 20 | nAdc |
| ON CHARACTERISTICS | | | | | _ | |
| DC Current Gain (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) | BCW67,A,68,F BCW67B,68G BCW67C | hFE | 75 120 180 | _ _ _ | = | _ |
| (I _C = 100 mAde, V _{CE} = 1.0 Vde) | BCW67,A,68,F BCW67B,68G BCW67C | | 100 160 250 | <u>-</u> - | 250 400 630 | |
| (I _C = 500 mAdc, V _{CE} = 1.0 Vdc) | BCW67,A,68,F BCW67B,68G BCW67C | | 35 60 100 | = | = | |
| Collector-Emitter Saturation Voltage (IC = | 100 mAdc, lg = 10 mAdc) | V _{CE(sat)} | | <u></u> | 0.3 | Vdc |
| Base-Emitter Saturation Voltage (IC = 500 | | VBE(sat) | <u> </u> | <u>L – </u> | 2.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product (IC = 20 mAdc, VCE = 10 Vdc, f = 100 N | MHz) | fτ | 100 | | | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = | | Cobo | 1 = | <u> </u> | 18 | pF |
| Input Capacitance (VEB = 0.5 Vdc, IC = 0 | , f = 1.0 MHz) | C _{ibo} | | <u> </u> | 80 | ρF |
| Noise Figure (IC = 0.2 mAdc, VCE = 5.0 f = 1.0 kHz, BW = 200 Hz) | Vdc, R _S = 1.0 k Ω , | NF | | | 10 | dB |

| Rating | Symbol | Value | Unit |
|--------------------------------|--------|-------|------|
| Collector-Emitter Voltage | VCEO | 45 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 100 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stq} | 150 | °C |
| *Thermal Resistance Junction to Ambient | ReJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

BCW69,70

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

Refer to 2N5086 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|------------|------------|--------------|
| OFF CHARACTERISTICS | | | | 1 |
| Collector-Emitter Breakdown Voltage (I _C = 2.0 mAdc, I _B = 0) | V(BR)CEO | 45 | | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 100 µAdc, VEB = 0) | V(BR)CES | 50 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | V(BR)EBO | 5.0 | - | Vdc |
| Collector Cutoff Current (VCB = 20 Vdc, !E = 0) (VCB = 20 Vdc, !E = 0, TA = 100°C) | ICBO | | 100 | nAdc #Adc |
| ON CHARACTERISTICS | · | | | 7 |
| DC Current Gain (I _C = 2.0 mAdc, V _{CE} = 5.0 Vdc) BCW69 BCW70 | hfE | 120 215 | 260 500 | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 0.5 mAdc) | V _{CE(sat)} | | 0.3 | Vdc |
| Base-Emitter On Voltage (IC = 2.0 mAdc, VCE = 5.0 Vdc) | V _{BE(on)} | 0.6 | 0.75 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | ı | l |
| Output Capacitance (IE = 0, VCB = 10 Vdc, f = 1.0 MHz) | C _{obo} | _ | 7.0 | pF |
| Noise Figure (I _C = 0.2 mAdc, V _{CE} = 5.0 Vdc, R _S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz) | NF | _ | 10 | dB |

BCW71,72

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 45 | Vdc |
| Collector-Base Voltage | V _{CBO} | 50 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 100 | mAdc |

THERMAL CHARACTERISTICS

| I LEVIANT CUMBACIEUS I ICO | | | |
|---|------------------|------------|-------------|
| Characteristic | Symbol | Max | Unit |
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | ℃ |
| *Thermal Resistance Junction to Ambient | RAJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

Refer to MPS3904 for graphs.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------------------|------------|----------|-------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 2.0 mAdc, VEB = 0) | V(BR)CEO | 45 | _ | _ | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 2.0 mAdc, VEB = 0) | V(BR)CES | 45 | _ | | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 50 | <u> </u> | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | V(BR)EBO | 5.0 | | - | Vdc |
| Collector Cutoff Current (VCB = 20 Vdc, IE = 0) (VCB = 20 Vdc, IE = 0, TA = 100°C) | СВО | | | 100 10 | nAdc μAdc |
| ON CHARACTERISTICS | | + | | | |
| DC Current Gain (I _C = 2.0 mAdc, V _{CE} = 5.0 Vdc) BCW71 BCW72 | hFE | 110 200 | - | 220 450 | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 0.5 mAdc) (IC = 50 mAdc, IB = 2.5 mAdc) | VCE(sat) | <u>-</u> | 0.21 | 0.25 | Vdc |
| Base-Emitter Saturation Voltage (IC = 50 mAdc, IB = 2.5 mAdc) | V _{BE(sat)} | | 0.85 | _ | Vdc |
| Base-Emitter On Voltage (IC = 2.0 mAdc, VCE = 5.0 Vdc) | VBE(on) | 0.6 | _ | 0.75 | Vdc |
| SMALL SIGNAL CHARACTERISTICS | | , | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 5.0 Vdc, f = 35 MHz) | fτ | | 300 | | MHz |
| Output Capacitance (IE = 0, VCE = 10 Vdc, f = 1.0 MHz) | Copo | | | 4.0 | pF |
| Input Capacitance (IC = 0, VEB = 0.5 Vdc, f = 1.0 MHz) | C _{ibo} | - | 9.0 | | pF |
| Noise Figure (IC = 0.2 mAdc, VCE = 5.0 Vdc, RS = 2.0 k Ω , f = 1.0 kHz, BW = 200 Hz) | NF | _ | _ | 10 | dB |

| Rating | | Va | | |
|--------------------------------|--------|-------|-------|------|
| | Symbol | BCX17 | BCX18 | Unit |
| Collector-Emitter Voltage | VCEO | 45 | 25 | Vdc |
| Collector-Base Voltage | VCBO | 50 | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc |
| Collector Current — Continuous | IC | 500 | | mAdd |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|-------------------|------------|-------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R ₀ JA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

BCX17,18

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

| Character | ristic | Symbol | Min | Тур | Max | Unit |
|--|----------------|----------------------|-----------------|--------------|--------------------------|--------------|
| OFF CHARACTERISTICS | | | 7.1 | | THE SPORE | HIN 000 |
| Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, I _B = 0) | BCX17 BCX18 | V(BR)CEO | 45 25 | AN TAGGER | and majors | Vdc |
| Collector-Emitter Breakdown Voltage (I _C = 10 μ Adc, I _C = 0) | BCX17 BCX18 | V(BR)CES | 50 30 | 000 <u> </u> | jAnd ka <u>u</u> pest | Vdc |
| Collector Cutoff Current (V _{CB} = 20 Vdc, I _E = 0) (V _{CB} = 20 Vdc, I _E = 0, T _A = 150°C) | F 140 | СВО | = | = | 100 5.0 | nAdc μAdc |
| Emitter Cutoff Current (VBE = 5.0 Vdc, I _C = 0) | 3.410 | IEBO | _ | - | 10 | μAdc |
| ON CHARACTERISTICS | | | | | Ar UE | gaVi |
| DC Current Gain (I _C = 100 mAdc, V _{CE} = 1.0 Vdc) (I _C = 300 mAdc, V _{CE} = 1.0 Vdc) (I _C = 500 mAdc, V _{CE} = 1.0 Vdc) | CAN | hFE | 100 70 40 | = | 600 | E_U |
| Collector-Emitter Saturation Voltage (I _C = 500 mAdc, I _B = 50 mAdc) | 319 | V _{CE(sat)} | - | - | 0.62 | Vdc |
| Base-Emitter On Voltage (I _C = 500 mAdc, V _{CE} = 1.0 Vdc) | (axag | V _{BE(on)} | - | - | 1.2 | Vdc |

BCX51 BCX52 **BCX53**

CASE 345-01, STYLE 1 SOT-89

GENERAL PURPOSE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS Symbol BCX51 BCX52 BCX53 Unit Rating Collector-Emitter Voltage 60 ¥α€Õ 45 Collector-Emitter Voltage 100 45 VCER 100 45

v Collector-Base Voltage ٧ VCBO Emitter-Base Voltage ٧ 5.0 5.0 **VEBO** 5.0 **Base Current** 0.1 0.1 Α 0.1 lΒ Α Collector Current — Continuous 1.0 1.0 1.0 lc °C **Operating and Storage Junction** TJ, Tstg -55 to +150 Temperature Range

٧

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|---------------|
| *Total Device Dissipation, TA = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 125 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 12 x 0.6 mm.

| Characteristic | | Symbol | Min | Max | Unit |
|---|-------------------------|---------------------|----------------------|-----------------|----------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 10 mA) (IC = 10 mA) (IC = 10 mA) | BCX51 BCX52 BCX53 | V(BR)CEO | 45 60 80 | | V |
| Collector-Base Breakdown Voltage (IC = 10 \(\mu A \)) (IC = 10 \(\mu A \)) (IC = 10 \(\mu A \)) | BCX51 BCX52 BCX53 | V(BR)CBO | 45 60 100 | | ٧ |
| Emitter-Base Breakdown Voltage (I _E = 10 µA) | | V(BR)EBO | 5.0 | | ٧ |
| Collector Cutoff Current (V _{CB} = 30 V) (V _{CB} = 30 V, T _J = 125°C) | | ICBO | <u>-</u> | 100 10 | nA μA |
| Emitter Cutoff Current (VEB = 3.0 V) | | l _{EBO} | _ | 100 | nA |
| ON CHARACTERISTICS | | | | | 7 |
| DC Current Gain (IC = 5.0 mA, V _{CE} = 2.0 V) (IC = 150 mA, V _{CE} = 2.0 V) (IC = 150 mA, V _{CE} = 2.0 V) (IC = 500 mA, V _{CE} = 2.0 V) | BCX51 BCX52,53 | pŁE | 25 40 40 25 | 250 160 — | _ |
| Collector-Emitter Saturation Voltage (IC = 500 mA, IB = 50 mA) | | VCE(sat) | | 0.5 | |
| Base-Emitter On Voltage (I _C = 500 mA, V _{CE} = 2.0 V) | | V _{BE(on)} | | 1.0 | |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (VCE = 5.0 V, IC = 10 mA, f = 35 MHz) | | fΤ | 50 | | MHz |

| Rating | Symbol | BCX54 | BCX55 | BCX56 | Unit |
|--------------------------------|--------|-------|-------|-------|------|
| Collector-Emitter Voltage | VCEO | 45 | 60 | 80 | v |
| Collector-Emitter Voltage | VCER | 45 | 60 | 100 | ٧ |
| Collector-Base Voltage | VCBO | 45 | 60 | 100 | v |
| Emitter-Base Voltage | VEBO | 5.0 | 5.0 | 5.0 | V |
| Base Current | Iв | 0.1 | 0.1 | 0.1 | Α |
| Collector Current — Continuous | lc l | 1.0 | 1.0 | 1.0 | A |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|---------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Storage Temperature | T _{stg} | 150 | •℃ |
| *Thermal Resistance Junction to Ambient | RAJA | 125 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 12 x 0.6 mm.

BCX54 BCX55 BCX56

CASE 345-01, STYLE 1 SOT-89

GENERAL PURPOSE TRANSISTOR

NPN SILICON

| Characteristic | | Symbol | Min | Max | Unit |
|--|-------------------------|----------------------|-------------------|-------------|----------|
| OFF CHARACTERISTICS | | | - | | |
| Collector-Emitter Breakdown Voltage (I _C = 10 mA) (I _C = 10 mA) (I _C = 10 mA) | BCX54 BCX55 BCX56 | V(BR)CEO | 45 60 80 | | V |
| Collector-Base Breakdown Voltage (I _C = 10 μ A) (I _C = 10 μ A) (I _C = 10 μ A) | BCX54 BCX55 BCX56 | V(BR)CBO | 45 60 100 | = | ٧ |
| Emitter-Base Breakdown Voltage (IE = 500 mA, IB = 50 mA) (IE = 10 μ A) (IE = 10 μ A) | BCX54 BCX55 BCX56 | V(BR)EBO | 5.0 5.0 5.0 | = | ٧ |
| Collector Cutoff Current (V _{CB} = 30 V) (V _{CB} = 30 V, T _J = 125°C) | | ІСВО | _ | 100 10 | nA μA |
| Emitter Cutoff Current (VEB = 3.0 V) | | EBO | _ | 100 | nA |
| ON CHARACTERISTICS | | | | | _ |
| DC Current Gain (IC = 5.0 mA, VCE = 2.0 V) (IC = 150 mA, VCE = 2.0 V) (IC = 500 mA, VCE = 2.0 V) | | hFE | 25 40 25 | 250 | _ |
| Collector-Emitter Saturation Voltage (IC = 500 mA, IB = 50 mA) | | V _{CE(sat)} | _ | 0.5 | V |
| Base-Emitter On Voltage (IC = 500 mA, VCE = 2.0 V) | | V _{BE(on)} | _ | 1.0 | ٧ |
| SMALL SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (VCE = 5.0 V, IC = 10 mA, f = 35 MHz) | | fT | 50 | _ | MHz |

BCX68

CASE 345-01, STYLE 1 SOT-89

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|--------|-------|------|
| Collector-Emitter Voltage | VCEO | 20 | ٧ |
| Collector-Emitter Voltage | VCES | 25 | V |
| Emitter-Base Voltage | VEBO | 5.0 | V |
| Base Current | lΒ | 100 | mA |
| Base Current — Maximum | IBM | 200 | mA |
| Collector Current — Continuous | lc | 1.0 | Α |
| Collector Current — Maximum | ICM | 2.0 | Α |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|---------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Storage Temperature | T _{stg} | 150 | _ •c |
| *Thermal Resistance Junction to Ambient | RøJA | 125 | •c⁄w |

^{*}Package mounted on 99.5% alumina 10 x 12 x 0.6 mm.

| Characteristic | Symbol | Min | Max | Unit |
|---|---------------------|----------------|---------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 10 mA) | V(BR)CEO | 20 | _ | ٧ |
| Collector Cutoff Current (VCB = = 25 V) | ІСВО | | 100 | nA |
| Emitter Cutoff Current (VEB = 5.0 V) | IEBO | | 10 | μА |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (V _C E = 10 V, I _C = 5.0 mA) (V _C E = 1.0 V, I _C = 0.5 A) (V _C E = 1.0 V, I _C = 1.0 A) | hfE | 50 85 60 | _ 375 _ | _ |
| Collector-Emitter Saturation Voltage (IC = 1.0 A, Ig = 100 mA) | VCE(sat) | | 0.5 | v |
| Base-Emitter On Voltage (V _{CE} = 10 V, I _C = 5.0 mA) (V _{CE} = 1.0 V, I _C = 1.0 A) | V _{BE(on)} | <u>-</u> | 0.6 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | т | |
| Current-Gain — Bandwidth Product (VCE = 5.0 V, IC = 10 mA, f = 20 MHz) | fτ | 65 | | MHz |

| Rating | Symbol | Value | Unit |
|--------------------------------|----------------|-------|------|
| Collector-Emitter Voltage | VCEO | 20 | V |
| Collector-Emitter Voltage | VCES | 25 | V |
| Emitter-Base Voltage | VEBO | 5.0 | V |
| Base Current | Iв | 100 | mA |
| Base Current — Maximum | IBM | 200 | mA |
| Collector Current — Continuous | l _C | 1.0 | A |
| Collector Current — Maximum | ICM | 2.0 | A |

THERMAL CHARACTERISTICS

| THE MINE OF PROPERTY OF | | | |
|---|------------------|------------|---------------|
| Characteristic | Symbol | Max | Unit |
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Storage Temperature | T _{stg} | 150 | ან |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 125 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 12 x 0.6 mm.

BCX69

CASE 345-01, STYLE 1 SOT-89

GENERAL PURPOSE TRANSISTOR

PNP SILICON

| Characteristic | Symbol | Min | Max | Unit |
|--|---------------------|-----------------------|-------------|------|
| OFF CHARACTERISTICS | | | | .* |
| Collector-Emitter Breakdown Voltage (I _C = 10 mA) | V(BR)CEO | 20 | - | V |
| Collector Cutoff Current (VCB = 25 V) | Ісво | _ | 100 | nA |
| Emitter Cutoff Current (VEB = 5.0 V) | IEBO | _ | 10 | μΑ |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (V _{CE} = 10 V, I _C = 5.0 mA) (V _{CE} = 1.0 V, I _C = 0.5 A) (V _{CE} = 1.0 V, I _C = 1.0 A) | hFE | 50 85 60 | 375 | _ |
| Collector-Emitter Saturation Voltage (IC = 1.0 A, IB = 100 mA) | VCE(sat) | - | 0.5 | ٧ |
| Base-Emitter On Voltage (V _{CE} = 10 V, I _C = 5.0 mA) (V _{CE} = 1.0 V, I _C = 1.0 A) | V _{BE(on)} | _ | 0.6 1.0 | ٧ |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (VCE = 5.0 V, IC = 10 mA, f = 20 MHz) | fτ | 65 | _ | MHz |

BCX70G,H,J,K

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 45 | Vdc |
| Collector-Base Voltage | V _{CBO} | 45 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc lc | 100 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | $R_{\theta JA}$ | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

Refer to MPS3904 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------------------------|---------------------|--------------------------|--------------------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 2.0 mAdc, IE = 0) | | V(BR)CEO | 45 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 1.0 µAdc, I _C = 0) | | V(BR)EBO | 5.0 | - | Vdc |
| Collector Cutoff Current (VCE = 32 Vdc) (VCE = 32 Vdc, TA = 150°C) | | ICES | - | 20 20 | nAdc µAdc |
| Emitter Cutoff Current (VEB = 4.0 Vdc, IC = 0) | | EBO | _ | 20 . | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 10 µAdc, V _{CE} = 5.0 Vdc) | BCX70G BCX70H BCX70J BCX70K | hFE | 20 40 100 | _ _ _ _ | _ |
| (I _C = 2.0 mAdc, V _{CE} = 5.0 Vdc) | BCX70G BCX70H BCX70J BCX70K | | 120 180 250 380 | 220 310 460 630 | |
| $(I_C = 50 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc})$ | BCX70G BCX70H BCX70J BCX70K | | 60 70 90 100 | = = | |
| Collector-Emitter Saturation Voltage (I _C = 50 mAdc, I _B = 1.25 mAdc) (I _C = 10 mAdc, I _B = 0.25 mAdc) | | VCE(sat) | _ | 0.55 0.35 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 50 mAdc, I _B = 1.25 mAdc) (I _C = 50 mAdc, I _B = 0.25 mAdc) | | VBE(sat) | 0.7 0.6 | 1.05 0.85 | Vdc |
| Base-Emitter On Voltage (I _C = 2.0 mAdc, V _{CE} = 5.0 Vdc) | | V _{BE(on)} | 0.55 | 0.75 | Vdc |

BCX70G,H,J,K

| ELECTRICAL CHARACTERISTICS (contin | ued) (Tx = 25°C unless otherwise noted) |
|---|--|
|---|--|

| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|--------------------------|--------------------------|--------------|
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 5.0 Vdc, f = 100 MHz) | fτ | 125 | - | MHz |
| Output Capacitance (VCE = 10 Vdc, I _C = 0, f = 1.0 MHz) | C _{obo} | | 4.5 | pF |
| Small-Signal Current Gain IC = 2.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) BCX701 1 | 125 175 250 350 | 250 350 500 700 | _ |
| Noise Figure (I _C = 0.2 mAdc, V_{CE} = 5.0 Vdc, R_S = 2.0 k Ω , f = 1.0 kHz, BW = 200 Hz) | NF | _ | 6.0 | dB |
| SWITCHING CHARACTERISTICS | | | | |
| Turn-On Time (I _C = 10 mAdc, I _{B1} = 1.0 mAdc) | ton | _ | 150 | ns |
| Turn-Off Time (I _{B2} = 1.0 mAdc, V _{BB} = 3.6 Vdc, R1 = R2 = 5.0 k Ω , R _L = 990 Ω) | toff | _ | 800 | กร |

BCX71G,H,J,K

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | V _{CEO} | 45 | Vdc |
| Collector-Base Voltage | V _{CBO} | 45 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 100 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| •Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | Reja | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

Refer to 2N5086 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|--------|----------------------|-----------|--------------|--------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 2.0 mAdc, Ig = 0) | | V(BR)CEO | 45 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 1.0 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current | | ICES | | | |
| (V _{CE} = 32 Vdc) | | 1 1 | _ | 20 20 | nAdc . |
| (V _{CE} = 32 Vdc, T _A = 150°C) | | | | 20 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain | | μŁΕ | | 1 | _ |
| (IC = 10 μ Adc, VCE = 5.0 Vdc) | BCX71G | | _ | - | |
| | BCX71H | 1 1 | 30 |) <i>– ,</i> | |
| | BCX71J | 1 1 | 40 100 | _ | 1 |
| | BCX71K | | 100 | - | l |
| (Ic = 2.0 mAdc, Vce = 5.0 Vdc) | BCX71G | 1 | 120 | 220 | |
| IIC - 510 HINDS ACE - SIG AGO) | BCX71H | | 140 | 310 | l . |
| | BCX71J | | 250 | 460 | |
| • | BCX71K | | 380 | 630 | |
| (IC = 50 mAde, VCE = 1.0 Vde) | BCX71G |) | 60 | _ | |
| ,,, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, | BCX71H | | 80 | _ | |
| | BCX71J | Ì | 100 | _ | 1 |
| | BCX71K | | 110 | _ | 1 |
| (IC = 2.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | BCX71G |] | 125 | 250 | } |
| MC TIP WILLIAM COL | BCX71H | | 175 | 350 | 1 |
| | BCX71J | | 250 | 500 | i |
| | BCX71K | | 350 | 700 | |
| Collector-Emitter Saturation Voltage | | VCE(sat) | | | Vdc |
| (IC = 10 mAdc, IB = 0.25 mAdc) | | | _ | 0.25 | |
| (IC = 50 mAdc, IB = 1.25 mAdc) | | | | 0.55 | |
| Base-Emitter Saturation Voltage | | V _{BE(sat)} | | 1 | Vdc |
| (IC = 10 mAdc, IB = 0.25 mAdc) | | | 0.6 | 0.85 | |
| (IC = 50 mAdc, IB = 1.25 mAdc) | | | 0.68 | 1.05 | |
| Base-Emitter On Voltage (IC = 2.0 mAdc, VCE = 5.0 Vdc) | | VBE(on) | 0.6 | 0.75 | Vdc |
| Output Capacitance (VCE = 10 Vdc, IC = 0, f = 1.0 MHz) | | Copo | | 6.0 | pF |

BCX71G,H,J,K

| Characteristic | Symbol | Min | Max | Unit |
|--|------------------|-----|-----|------|
| Noise Figure (I _C = 0.2 mAdc, V _{CE} = 5.0 Vdc, R _S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz) | NF | _ | 6.0 | dB |
| SWITCHING CHARACTERISTICS | | | | |
| Turn-On Time (I _C = 10 mAdc, I _{B1} = 1.0 mAdc) | ton | | 150 | , ns |
| Turn-Off Time (I _{B2} = 1.0 mAdc, V_{BB} = 3.6 Vdc, R1 = R2 = 5.0 k Ω , R1 = R90 Ω) | ^t off | - | 800 | ns |

BFQ17

CASE 345-01, STYLE 1 SOT-89

RF TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|----------|-------------|------|
| Collector-Emitter Voltage | VCEO | 25 | v |
| Collector-Emitter Voltage (RBE ≤ 50 Ω) | VCER | 40 | ٧ |
| Collector-Base Voltage | VCBO | 40 | ٧ |
| Emitter-Base Voltage | VEBO | 2.0 | ٧ |
| Collector Current — Continuous | lc | 300 | mA |
| Operating and Storage Junction Temperature Range | TJ, Tstg | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------------|---------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Storage Temperature | Tstg | 150 | ℃ |
| *Thermal Resistance Junction to Ambient | RAIA | 125 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 12 x 0.6 mm.

| Characteristic | Symbol | Min | Max | Unit |
|--|------------------|----------|-----------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 10 mA) | V(BR)CEO | 25 | _ | ٧ |
| Collector-Base Breakdown Voltage (IC = 10 µA) | V(BR)CBO | 40 | - | ٧ |
| Emitter-Base Breakdown Voltage (Ig = 10 µA) | V(BR)EBO | 2.0 | _ | ٧ |
| Collector Cutoff Current (V _{CB} = 20 V) (V _{CB} = 20 V, T _A = 150°C) | СВО | _ | 100 20 | nA |
| Emitter Cutoff Current (VEB = 1.0 V) | [†] EBO | ·- | 100 | nΑ |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 50 mA, V _{CE} = 5.0 V) (I _C = 150 mA, V _{CE} = 5.0 V) | μŁΕ | 25 25 | _ | - |
| Collector-Emitter Saturation Voltage (I _C = 100 mA, I _B = 10 mA) | VCE(sat) | - | 0.5 | V |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (VCE = 15 V, IC = 150 mA, f = 500 MHz) | fτ | 1200(1) | _ | MHz |
| Collector-Base Capacitance (V _{CB} = 15 V, f = 1.0 MHz) | C _{cb} | - | 4.0 | pF |
| Reverse Transfer Capacitance Common-Emitter (VCF = 15 V, IC = 10 mA, f = 1.0 MHz) | C _{re} | _ | 1.9 | pF |

⁽¹⁾ Typical only

BFQ18A

CASE 354-01, STYLE 1 SOT-89

RF TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|------|
| Collector-Emitter Voltage | VCEO | 15 | ٧ |
| Collector-Base Voltage | VCBO | 25 | ٧ |
| Emitter-Base Voltage | VEBO | 12 | ٧ |
| Collector Current — Continuous | lc | 150 | mA |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|---------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 125 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 12 x 0.6 mm.

| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|----------|-----|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 10 mA) | V(BR)CEO | 15 | - | ٧ |
| Collector-Base Breakdown Voltage (IC = 10 µA) | V(BR)CBO | 25 | _ | ٧ |
| Emitter-Base Breakdown Voltage (I _E = 10 μA) | V(BR)EBO | 2.0 | - | ٧ |
| Collector Cutoff Current (VCB = 10 V) | ¹ СВО | _ | 100 | пА |
| Emitter Cutoff Current (VEB = 1.0 V) | lebo | _ | 100 | nΑ |
| ON CHARACTERISTICS | - | | | |
| DC Current Gain (IC = 50 mA, VCE = 10 V) (IC = 100 mA, VCE = 10 V) | hFE | 25 25 | = | _ |
| SMALL SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (VCE = 10 V, IC = 50 mA, f = 500 MHz) | fΤ | 3200(1) | - | MHz |

⁽¹⁾ Typical only

BFQ19

CASE 345-01, STYLE 1 SOT-89

RF TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|------|
| Collector-Emitter Voltage | VCEO | 15 | ٧ |
| Collector-Base Voltage | VCBO | 20 | ٧ |
| Emitter-Base Voltage | VEBO | 3.0 | V |
| Collector Current Max (f > 1.0 MHz) | ICM | 150 | mA |
| Collector Current — Average | ICAV | 75 | mA |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | .€ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|---------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | RøJA | 125 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 12 x 0.6 mm.

| Characteristic | Symbol | Min | Max | Unit |
|--|---|------------|-----|------|
| OFF CHARACTERISTICS | *************************************** | | | |
| Collector-Emitter Breakdown Voltage (IC = 10 mA) | V(BR)CEO | 15 | _ | ٧ |
| Collector-Base Breakdown Voltage | V(BR)CBO | 20 | _ | ٧ |
| Emitter-Base Breakdown Voltage (I _E = 10 μA) | V(BR)EBO | 3.0 | _ | V |
| Collector Cutoff Current (VCB = 10 V) | ІСВО | - | 100 | nA |
| Emitter Cutoff Current (V _{EB} = 1.0 V) | [[] EBO | - | 100 | nA |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 50 mA, VCE = 10 V) (IC = 75 mA, VCE = 10 V) | phE | 25 25 | = | - |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 50 mA, VCE = 10 V, f = 500 MHz) (IC = 75 mA, VCE = 10 V, f = 500 MHz) | fτ | 4.0 4.4 | = | GHz |
| Collector-Base Capacitance (VCB = 10 V, f = 1.0 MHz) | C _{cb} | _ | 1.6 | pF |
| Capacitance Emitter-to-Base (VEB = 0.5 V, f = 1.0 MHz) | C _{eb} | _ | 5.0 | pF |
| Reverse Transfer Capacitance Common Emitter (VCE = 10 V, IC = 10 mA, f = 1.0 MHz) | C _{re} | - | 1.3 | pF |
| Noise Figure (IC = 50 mA, V_{CE} = 10 V, f = 500 MHz) | NF | _ | 3.3 | dB |

BFR30,31

CASE 318-02/03, STYLE 10 SOT-23 (TO-236AA/AB)

JFET AMPLIFIER

N-CHANNEL

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|----------------------|--------|-------|------|
| Drain-Source Voltage | VDS | 25 | Vdc |
| Gate-Source Voltage | VGS | 25 | Vdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, TA = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | | Symbol | Min | Max | Unit |
|---|----------------------------------|------------------|---------------------------|-----------------|------|
| OFF CHARACTERISTICS | | | | | |
| Gate Reverse Current (VGS = 10 Vdc, VDS = 0) | | l _{GSS} | - | 0.2 | nAdc |
| Gate Source Cutoff Voltage (ID = 0.5 nAdc, VDS = 10 Vdc) | BFR30 BFR31 | VGS(off) | _ | 5.0 2.5 | Vdc |
| Gate Source Voltage (ID = 1.0 mAdc, V _{DS} = 10 Vdc) | BFR30 BFR31 | VGS | 0.7 | 3.0 1.3 | Vdc |
| $(I_D = 50 \mu\text{Adc}, V_{DS} = 10 \text{Vdc})$ | BFR30 BFR31 | | _ | 4.0 2.0 | |
| ON CHARACTERISTICS | | | | | • |
| Zero-Gate-Voltage Drain (VDS = 10 Vdc, VGS = 0) | BFR30 BFR31 | l _{DSS} | 4.0 1.0 | 10 5.0 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | - N. | |
| Forward Transfer Admittence (ID = 1.0 mAdc, V_{DS} = 10 Vdc, f = 1.0 kHz) (ID = 200 μ Adc, V_{DS} = 10 Vdc, f = 1.0 kHz) | BFR30 BFR31 BFR30 BFR31 | Y _{fs} | 1.0 1.5 0.5 0.75 | 4.0 4.5 — | mAdc |
| Output Admittance (ID = 1.0 mAdc, VDS = 10 Vdc, f = 1.0 kHz) (ID = 200 µAdc, VDS = 10 Vdc) | BFR31 BFR31 | Yos | 40 20 | 25 15 | μAdc |
| Input Capacitance (ID = 1.0 mAdc, V _{DS} = 10 Vdc, f = 1.0 MHz) (ID = 200 µAdc, V _{DS} = 10 Vdc, f = 1.0 MHz) | | C _{iss} | = | 5.0 4.0 | pF |
| Reverse Transfer Capacitance (Ip = 1.0 mAdc, Vps = 10 Vdc, f = 1.0 MHz) (Ip = 200 µAdc, Vps = 10 Vdc, f = 1.0 MHz) | | C _{rss} | = | 1.5 1.5 | pF |

BFR92,S

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

RF TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 15 | Vdc |
| Collector-Base Voltage | VCBO | 20 | Vdc |
| Emitter-Base Voltage | V _{EBO} | 2.0 | Vdc |
| Collector Current — Continuous | lc lc | 25 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | Tstg | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------|----------------------|----------------|----------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mA) | | V(BR)CEO | 15 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μA) | | V(BR)CBO | 20 | _ | Vdc |
| Emitter-Base Breakdown Voltage (Ig = 100 µA) | | V(BR)EBO | 2.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 10 V) | | ICEO | _ | 50 | nA |
| Collector Cutoff Current (VCB = 10 V) | | iсво | - | 50 | nA |
| Emitter Cutoff Current (VEB = 1.0 V) | | IEBO | _ | 10 | nA |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 500 µA, V _{CE} = 10 V) (I _C = 3.0 mA, V _{CE} = 1.5 V) (I _C = 14 mA, V _{CE} = 10 V)(1) | BFR92S | hFE | 25 30 25 | 100 — | _ |
| Collector-Emitter Saturation Voltage(1) (IC = 25 mA, Ig = 5.0 mA) | | V _{CE(sat)} | _ | 0.5 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 25 mA, IB = 5.0 mA) | | V _{BE(sat)} | _ | 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 14 mA, VCE = 10 V, f = 500 MHz) | | fT | 4.5 | _ | MHz |
| Noise Figure (VCF = 1.5 V, $I_{\rm C}$ = 3.0 mA, $R_{\rm S}$ = 50 Ω , f = 30 MHz) | - | NF | _ | 3.0 | dB |

⁽¹⁾ Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 12 | Vdc |
| Collector-Base Voltage | V _{CBO} | 15 | Vdc |
| Emitter-Base Voltage | VEBO | 2.0 | Vdc |
| Collector Current — Continuous | lc lc | 25 | mAdc |

THERMAL CHARACTERISTICS

| Cheracteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | RAJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

BFR93,S

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

RF TRANSISTOR

NPN SILICON

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------|--|----------------|-------------|-------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 10 mA) | | V(BR)CEO | 12 | _ | Vdc . |
| Collector-Base Breakdown Voltage (I _C = 10 µA) | | V(BR)CBO | 15 | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μA) | | V(BR)EBO | 2.0 | -, | Vdc |
| Collector Cutoff Current (VCE = 10 V) | | ICEO | _ | 50 | nA |
| Collector Cutoff Current (VCB = 10 V) | | ICBO | | 50 | nA |
| Emitter Cutoff Current (VEB = 1.0 V) | | IEBO | _ | . 10 | nA |
| ON CHARACTERISTICS | | ' | | <u> </u> | |
| DC Current Gain (I _C = 1.0 mA, V _{CE} = 5.0 V) (I _C = 20 mA, V _{CE} = 4.0 V) (I _C = 30 mA, V _{CE} = 5.0 V) | BFR93S | pŁE | 25 30 25 | 100 | _ |
| Collector-Emitter Saturation Voltage (I _C = 35 mA, I _B = 7.0 mA) | | V _{CE(sat)} | _ | 0.5 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 35 mA, I _B = 7.0 mA) | | V _{BE(sat)} | _ | 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | ± | | | <u> </u> |
| Current-Gain — Bandwidth Product (IC = 30 mA, VCE = 5.0 V, f = 500 MHz) | | fr | 4.5 | <u> </u> | GHz |
| Noise Figure (VCE = 5.0 V, IC = 2.0 mA, RS = 50 Ω , f = 30 MHz) | | . NF | _ | 3.0 | dB |

BFS17,S

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

RF TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 15 | Vdc |
| Collector-Base Voltage | V _{СВО} | 25 | Vdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | . Max | Unit | | |
|---|------------------|------------|------------|--|--|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/℃ | | |
| Storage Temperature | T _{stg} | . 150 | °C | | |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W | | |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | | Symbol | Min | Max | Unit |
|---|-----------------|----------|----------------|------------|----------|
| OFF CHARACTERISTICS | | | | · | |
| Collector-Emitter Breakdown Voltage (IC = 10 mA) | | V(BR)CEO | 15 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μA) | | V(BR)CBO | 25 | - | Vdc |
| Collector Cutoff Current (VCE = 10 V) | | ICEO | _ | 25 | nA |
| Collector Cutoff Current (VCB = 15 V) | | ICBO | _ | 25 | nΑ |
| Emitter Cutoff Current (VEB = 1.0 V) | | IEBO | - | 10 | nA |
| ON CHARACTERISTICS | | • | | | <u> </u> |
| DC Current Gain (I _C = 2.0 mA, V _{CE} = 1.0 V) (I _C = 2.0 mA, V _{CE} = 1.0 V) (I _C = 25 mA, V _{CE} = 1.0 V) | BFS17 BFS17S | pŁĘ | 20 50 20 | 150 150 | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mA, I _B = 1.0 mA) | | VCE(sat) | _ | 0.4 | V |
| Base-Emitter Saturation Voltage (IC = 10 mA, Ig = 1.0 mA) | | VBE(sat) | _ | 1.0 | ٧ |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (I _C = 2.0 mA, V _{CE} = 5.0 V, f = 500 MHz) (I _C = 25 mA, V _{CE} = 5.0 V, f = 500 MHz) | | fT | 1.0 | = | GHz |
| Output Capacitance (VCB = 10 V, f = 1.0 MHz) | | Copo | _ | 1.5 | pF |
| Noise Figure (I _C = 2.0 mA, V _{CE} = 5.0 V, R _S = 50 Ω , f = 30 MHz) | | NF | _ | 5.0 | d₿ |

| Rating | Symbol | Value | Unit |
|--|--------|-------|------|
| Collector-Emitter Voltage | VCEO | 100 | Vdc |
| Collector-Emitter Voltage R _{BE} = 10 kΩ | VCER | 110 | Vdc |
| Collector Current — Continuous | lc | 100 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | ℃ |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

BSS63

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

HIGH VOLTAGE TRANSISTOR

PNP SILICON

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|----------------------|----------|------------|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 100 μAdc) | V(BR)CEO | 100 | _ | _ | ·Vdc |
| Collector-Emitter Breakdown Voltage (I _C = 10 μAdc, I _E = 0, R _{BE} = 10 kΩ) | V(BR)CER | 110 | 1 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 110 | . - | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc) | V(BR)EBO | 6.0 | - | _ | Vdc |
| Collector Cutoff Current (VCB = 90 Vdc, IE = 0) | ICBO | - | - | 100 | nAdc |
| Collector Cutoff Current (VCE = 110 Vdc, RBE = 10 kΩ) | ICER | 1 | • | 10 | μAdc |
| Emitter Cutoff Current (VEB = 6.0 Vdc, IC = 0) | IEBO | _ | 1 | 200 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) (I _C = 25 mAdc, V _{CE} = 1.0 Vdc) | hFE | 30 30 | 11 | = | _ |
| Collector-Emitter Saturation Voltage (I _C = 25 mAdc, I _B = 2.5 mAdc) | VCE(sat) | <u> </u> | _ | 250 | mVdc |
| Base-Emitter Saturation Voltage (IC = 25 mAdc, IB = 2.5 mAdc) | V _{BE(sat)} | | - | 900 | mVdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 25 mAdc, VCE = 5.0 Vdc, f = 35 MHz) | fT | 50 | 95 | _ | MHz |
| Case Capacitance (I _E = I _C = 0, V _{CB} = 10 Vdc) | СС | _ | _ | 5.0 | pF |

BSS64

CASE 318-03, STYLE 6 SOT-23 (TO-236AA/AB)

DRIVER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | V _{CEO} | 80 | Vdc |
| Collector-Base Voltage | V _{CBO} | 120 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 100 | mA |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit | | |
|---|------------------|------------|-------------|--|--|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C | | |
| Storage Temperature | T _{stg} | 150 | °C | | |
| *Thermal Resistance Junction to Ambient | ReJA | 357 | °C/W | | |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | Symbol | Min | Max | Unit |
|---|----------|-----|------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 4.0 mA) | V(BR)CEO | 80 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µA) | V(BR)CBO | 120 | _ | Vdc |
| Emitter-Base Breakdown Voltage (Ig = 100 µA) | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 80 V, TA = 70°C) | ICES | _ | 20 | μА |
| Emitter Cutoff Current (VBE = 4.0 V) | lebo | | 200 | пА |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (VCE = 1.0 V, IC = 10 mA) | hFE | 20 | _ | _ |
| Collector-Emitter Saturation Voltage (IC = 4.0 mA, IB = 400 μ A) (IC = 50 mA, IB = 15 mA) | VCE(sat) | _ | 0.7 3.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 4.0 mA, VCE = 10 V, f = 35 MHz) | fT | 50 | - | MHz |

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | V _{CEO} | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 75 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | Vdc |
| Collector Current — Continuous | lc lc | 100 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

BSS79C

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

| Characteristic | Symbol | Min | Max | Unit |
|--|------------------|--------------|------------|--------------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage { C = 10 mAdc | V(BR)CEO | 40 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc) | V(BR)CBO | 75 | _ | Vdc |
| Emitter-Bese Breakdown Voltage (I _E = 10 μAdc) | V(BR)EBO | 6.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 60 Vdc) (VCB = 60 Vdc, TA = 150°C) | ІСВО | - | 10 10 | nAdc µAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc) | IEBO | - | 10 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 150 mAdc, VCE = 10 Vdc) | hFE | 100 | 300 - | _ |
| Collector-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) (IC = 500 mAdc, IB = 50 mAdc) | VCE(sat) | = | 0.3 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | · |
| Current-Gain — Bandwidth Product (VCE = 20 Vdc, IC = 20 mAdc, f = 100 MHz) | fT | 250 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, f = 1.0 MHz) | C _{obo} | _ | 8.0 | pF |
| SWITCHING CHARACTERISTICS | | | | |
| Delay Time (VCC = 30 Vdc, I _C = 150 mAdc) (I _{B1} = I _{B2} = 15 mAdc) | td | _ | 10 | ns |
| Rise Time {V _{CC} = 30 Vdc, I _C = 150 mAdc} {I _{B1} = I _{B2} = 15 mAdc} | tr | | 10 | ns |
| Storage Time (V _{CC} = 30 Vdc, I _C = 150 mAdc) (I _{B1} = I _{B2} = 15 mAdc) | t _S | _ | 225 | ns |
| Fall Time (V _{CC} = 30 Vdc, I _C = 150 mAdc) (I _{B1} = I _{B2} = 15 mAdc) | tf | _ | 60 | ns |

BSS80C

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|--------|-------|------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | VCBO | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | ¹c | 800 | mA |

THERMAL CHARACTERISTICS

| TILLWAL GRANG LINGTIGG | | | | | |
|---|------------------|------------|-------------|--|--|
| Characteristic | Symbol | Max | Unit | | |
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C | | |
| Storage Temperature | T _{stg} | 150 | °C | | |
| *Thermal Resistance Junction to Ambient | RøJA | 357 | °C/W | | |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------|-----|------------|----------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 10 mA) | V(BR)CEO | 40 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 μA) | V(BR)CBO | 60 | | Vdc |
| Emitter-Base Breakdown Voltage (lg = 10 μA) | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 50 Vdc) (V _{CB} = 50 Vdc, T _A = 150°C) | Ісво | _ | 10 10 | πA μA |
| Emitter Cutoff Current (VBE = 3.0 Vdc) | IEBO | - | 10 | nΑ |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 150 mA, VCE = 10 Vdc) | hFE | 100 | 300 | _ |
| Collector-Emitter Saturation Voltage (IC = 150 mA, IB = 15 mA) (IC = 500 mA, IB = 50 mA) | VCE(sat) | | 0.4 1.6 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 50 mA, VCE = 20 Vdc, f = 100 MHz) | fτ | 200 | | MHz |
| Output Capacitance (VCB = 10 Vdc, f = 1.0 MHz) | Cobo | _ | 8.0 | pF |
| SWITCHING CHARACTERISTICS | | | | |
| Delay Time (IB1 ~ IB2 ~ 15 mA, | ^t d | - | 10 | ns |
| Rise Time V _{CC} = 30 V, I _C = 150 mA) | tr | | 40 | ns |
| Storage Time (IB1 ~ IB2 ~ 15 mA, | ts | _ | 80 | ns |
| Fall Time V _{CC} = 30 V, I _C = 150 mA) | tf | _ | 30 | ns |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| Rating | Symbol | Value | Unit | |
|---------------------------|------------------|-------|------|--|
| Collector-Emitter Voltage | VCEO | 60 | Vdc | |
| Collector-Base Voltage | V _{СВО} | 60 | Vdc | |
| Emitter-Base Voltage | VERO | 5.0 | Vdc | |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | RAJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

BSS82C

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

| Characteristic | Symbol | Min | Max | Unit |
|--|----------|-----|------------|----------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 10 mA) | V(BR)CEO | 60 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µA) | V(BR)CBO | 60 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μA) | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 50 V) (VCB = 50 V, TA = 150°C) | ICBO | | 10 10 | nA μA |
| Emitter Cutoff Current (VEB = 3.0 V) | IEBO | | 10 | nA |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 150 mA, VCE = 10 V) | hte | 100 | 300 | |
| Collector-Emitter Saturation Voltage (IC = 150 mA, IB = 15 mA) (IC = 500 mA, IB = 50 mA) | VCE(sat) | _ | 0.4 1.6 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | • | | |
| Current-Gain — Bandwidth Product (IC = 50 mA, VCF = 20 V, f = 200 MHz) | fT | 100 | - | MHz |

BSV52

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 12 | Vdc |
| Collector-Base Voltage | V _{CBO} | 20 | Vdc |
| Emitter-Base Voltage | V _{EBO} | 20 | Vdc |
| Collector Current — Continuous | lc | 200 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| •Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | ROJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|-----------------|-------------------|--------------|
| OFF CHARACTERISTICS | · · · · · | | | • |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc) | V(BR)CEO | 12 | - | Vdc |
| Collector Cutoff Current (VCB = 10 Vdc, IE = 0) (VCB = 10 Vdc, IE = 0, TA = 125°C) | ſCBO | _ | 100 5.0 | πAdc μAdc |
| ON CHARACTERISTICS | | _ | | |
| DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) (I _C = 50 mAdc, V _{CE} = 1.0 Vdc) | hFE | 25 40 -25 | 120 — | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 300 \(\mu Adc\)) (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc) | VCE(sat) | = | 300 250 400 | mVdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc) | V _{BE(sat)} | 700 — | 850 1200 | mVdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 10 Vdc) | fŢ | 400 | _ | MHz |
| Output Capacitance (VCB = 5.0 Vdc, IE = 0, f = 1.0 MHz) | C _{obo} | _ | 4.0 | pF |
| Input Capacitance (VEB = 1.0 Vdc, IC = 0) | C _{ibo} | _ | 4.5 | pF |
| SWITCHING CHARACTERISTICS | | | | |
| Storage Time (IC = IB = IBM = 10 mAdc) | t _S | _ | 13 | ns |
| Turn-On Time (VBE = 1.5 Vdc, I _C = 10 mAdc, I _B = 3.0 mAdc) | ton | _ | 12 | ns |
| Turn-Off Time (I _C = 10 mAdc, I _B = 3.0 mAdc) | ^t off | _ | 18 | ns |

BSX39

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|--------|-------|------|
| Collector-Emitter Voltage | VCEO | 14 | Vdc |
| Collector Current — Continuous | lc lc | 200 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/℃ |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | RAJA | 357 . | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | Symbol | Min | Max | Unit |
|---|----------------------|----------------|-------------|----------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 2.0 mA) | V(BR)CEO | 14 | _ | Vdc |
| Collector Cutoff Current (VCB = 12 V) | ІСВО | _ | 100 | пA |
| Collector Cutoff Current (VCE = 12 V) (VCE = 12 V, T _J = 125°C) | ICES | | 100 5.0 | nA μA |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 1.0 mA, V _{CE} = 1.0 V) (IC = 10 mA, V _{CE} = 1.0 V) (IC = 50 mA, V _{CE} = 1.0 V) | hFE | 25 40 25 | 200 | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mA, IB = 1.0 mA) (IC = 50 mA, IB = 5.0 mA) | V _{CE(sat)} | | 250 400 | mV |
| Base-Emitter Saturation Voltage (I _C = 10 mA, I _B = 1.0 mA) (I _C = 50 mA, I _B = 5.0 mA) | V _{BE(sat)} | 700 — | 850 1.2 | mV V |
| SWITCHING CHARACTERISTICS | | | | |
| Turn-On Time (IC = 10 mA, IB = 3.0 mA) | ton | _ | 12 | ns |
| Turn-Off Time (I _C = 10 mA, I _{B1} = I _{B2} = 3.0 mA) | ^t off | _ | 18 | ns |

BZX84C

CASE 318-02/03, STYLE 8 SOT-23 (TO-236AA/AB) ZENER DIODES

MAXIMUM RATINGS

| Rating | Symbol | · Value | Unit |
|---------------|---------------------|-----------|------|
| Voltage Range | V _{Z(nom)} | 4.7 to 33 | Vdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | •€ |
| *Thermal Resistance Junction to Ambient | ReJA | 357 | •c⁄w |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Code | Marking | Code | Marking | Code | Marking |
|------------|------------|-----------|---------|-----------|---------|
| BZX84-C4V7 | Z1 | BZX84-C11 | Y1 | BZX84-C27 | Y10 |
| BZX84-C5V1 | Z2 | BZX84-C12 | Y2 | BZX84-C30 | Y11 |
| BZX84-C5V6 | Z3 | BZX84-C13 | Y3 | BZX84-C33 | Y12 |
| BZX84-C6V2 | Z4 | BZX84-C15 | Y4 | | |
| BZX84-C6V8 | Z 5 | BZX84-C16 | Y5 | | _ |
| BZX84-C7V5 | Z6 | BZX84-C18 | Y6 | | |
| BZX84-C8V2 | Z7 | BZX84-C20 | Y7 | | |
| BZX84-C9V1 | Z8 | BZX84-C22 | Y8 | | - |
| BZX84-C10 | Z9 | BZX84-C24 | Y9 | | |

| Characteristic | | Symbol | Min | Max | Unit |
|---------------------------------|------------------------|----------------|----------|------|------|
| OFF CHARACTERISTICS | | | | | |
| Forward Voltage | | VF | _ | 0.9 | Vdc |
| (IF = 10 mAdc) | BZX84 Series | | | | |
| Reverse Voltage Leakage Current | | I _R | | | μAdc |
| (VR = 2.0 Vdc) | BZX84-C4V7 | '' | l — | 3.0 | 1 |
| 1.11 | BZX84-C5V1 | | i — | 2.0 | 1 |
| | BZX84-C5V6 | | _ | 1.0 | l |
| (VR = 4.0 Vdc) | BZX84-C6V2 | 1 | _ | 3.0 | - |
| | BZX84-C6V8 | İ | – | 2.0 | 1 |
| (V _R = 5.0 Vdc) | BZX84-C7V5 | | _ | 1.0 | |
| | BZX84-C8V2 | | _ | 0.7 | [|
| (V _R = 6.0 Vdc) | BZX84-C9V1 | - (| _ | 0.5 | [|
| (VR = 7.0 Vdc) | BZX84-C10 | | l – | 0.2 | l |
| (V _R = 8.0 Vdc) | BZX84-C11, C12, C13 | | l – | 0.1 | Ì |
| $(V_R = 0.70 V_Z)$ | BZX84-C15 to BZX84-C33 | | l – | 0.05 | |

ŻENER VOLTAGE

| Device | IZ3(mA) | V _Z : | 3(V) | Z _{ZT1} | Z _{ZT2} | Z _{ZT3} (Ω) | ΔV _Z /Δ | T(nV/k) |
|-----------|---------|------------------|------|------------------|------------------|----------------------|--------------------|---------|
| BZX84C4V7 | 20 | 4.4 | 5.1 | 80 | 500 | 15 | -3.5 | 0.2 |
| BZX84C5V1 | 20 | 4.8 | 5.5 | 60 | 480 | 15 | - 2.7 | 1.2 |
| BZX84C5V6 | 20 | 5.2 | 6.3 | 40 | 400 | 10 | - 2.0 | 2.5 |
| BZX84C6V2 | 20 | 5.8 | 6.8 | 10 | 150 | 6 | 0.4 | 3.7 |
| BZX84C6V8 | 20 | 6.4 | 7.4 | 15 | 80 | 6 | 1.2 | 4.5 |
| BZX84C7V5 | 20 | 7.0 | 8.0 | 15 | 80 | 6 | 2.5 | 5.3 |
| BZX84C8V2 | 20 | 7.7 | 8.8 | 15 | 80 | 6 | 3.2 | 6.2 |
| BZX84C9V1 | 20 | 8.5 | 9.7 | 15 | 100 | 8 | 3.8 | 7.0 |
| BZX84C10 | 20 | 9.4 | 10.7 | 20 | 150 | ,10 | 4.5 | · 8.0 |
| BZX84C11 | 20 | 10.4 | 11.8 | 20 | 150 | 10 | 5.4 | 9.0 |
| BZX84C12 | 20 | 11.4 | 12.9 | 25 | 150 | 10 | 6.0 | 10 |
| BZX84C13 | 20 | 12.5 | 14.2 | 30 | 170 | 15 | 7.0 | 11 |
| BZX84C15 | 20 | 13.9 | 15.7 | 30 | 200 | 20 | 9.2 | 13 |
| BZX84C16 | 20 | 15.4 | 17.2 | 40 | 200 | 20 | 10.4 | 14 |
| BZX84C18 | 20 | 16.9 | 19.2 | 45 | 225 | 20 | 12.4 | 16 |
| BZX84C20 | 20 | 18.9 | 21.4 | 55 | 225 | 20 | 14.4 | 18 |
| BZX84C22 | 20 | 20.9 | 23.4 | 55 | 250 | 25 | 16.4 | 20 |
| BZX84C24 | 20 | 22.9 | 25.7 | 70 | 250 | 25 | 18.4 | 22 |
| BZX84C27 | 10 | 25.2 | 29.3 | 80 | 300 | 45 | 21.4 | 25.3 |
| BZX84C30 | 10 | 28.1 | 32.4 | 80 | 300 | 50 | 24.4 | 29.4 |
| BZX84C33 | 10 | 31.1 | 35.4 | 80 | 325 | 55 | 27.4 | 33.4 |

| Device | Iz1(mA) | V ₂ | 21(V) | IZ1(mA) | VZ | ₂ (V) |
|-----------|---------|----------------|-------|---------|------|------------------|
| BZX84C4V7 | 5 | 4.4 | 5.0 | 1 | 3.7 | 4.7 |
| BZX84C5V1 | 5 | 4.8 | 5.4 | 1 | 4.2 | 5.3 |
| BZX84C5V6 | 5 | 5.2 | 6.0 | 1 | 4.8 | 6.0 |
| BZX84C6V2 | 5 | 5.8 | 6.6 | 1 | 5.6 | 6.6 |
| BZX84C6V8 | 5 | 6.4 | 7.2 | 1 | 6.3 | 7.2 |
| BZX84C7V5 | 5 | 7.0 | 7.9 | 1 | 6.9 | 7.9 |
| BZX84C8V2 | 5 | 7.7 | 8.7 | 1 | 7.6 | 8.7 |
| BZX84C9V1 | 5 | 8.5 | 9.6 | 1 | 8.4 | 9.6 |
| BZX84C10 | 5 | 9.4 | 10.6 | 1 | 9.3 | 10.6 |
| BZX84C11 | 5 | 10.4 | 11.6 | 1 | 10.2 | 11.6 |
| BZX84C12 | 5 | 11.4 | 12.7 | 1 | 11.2 | 12.7 |
| BZX84C13 | . 5 | 12.4 | 14.1 | 1 | 12.3 | 14 |
| BZX84C15 | 5 | 13.8 | 15.6 | 1 | 13.7 | 15.5 |
| BZX84C16 | 5 | 15.3 | 17.1 | 1 | 15.2 | 17 |
| BZX84C18 | 5 | 16.8 | 19.1 | 1 | 16.7 | 19 |
| BZX84C20 | 5 | 18.8 | 21.2 | 1 | 18.7 | 21.1 |
| BZX84C22 | 5 | 20.8 | 23.3 | 1 | 20.7 | 23.2 |
| BZX84C24 | 5 | 22.8 | 25.6 | 1 | 22.7 | 25.5 |
| BZX84C27 | 2 | 25.1 | 28.9 | 0.5 | 25 | 28.9 |
| BZX84C30 | 2 | 28 | 32 | 0.5 | 27.8 | 32 |
| BZX84C33 | 2 | 31 | 35 | 0.5 | 30.8 | 35 |

MMBA811C5,6,7,8

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | V _{CEO} | 45 | Vdc |
| Collector-Base Voltage | VCBO | 50 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 50 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

Refer to 2N5086 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|--|---------------------|---|-------------------------------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc) | | V(BR)CEO | 45 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μAdc) | | V(BR)CBO | 50 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _C = 10 μAdc) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 40 Vdc) | | ІСВО | | 50 | nAdc |
| Emitter Cutoff Current (VEB = 5.0 Vdc) | | !EBO | - | 50 | nAdc |
| ON CHARACTERISTICS | | | | | - |
| DC Current Gain (IC = 0.1 mAdc, VCE = 3.0 Vdc) (IC = 0.5 mAdc, VCE = 3.0 Vdc) (For Reference Only) (IC = 0.5 mAdc, VCE = 3.0 Vdc) | MMBA811C5 MMBA811C6 MMBA811C7 MMBA811C8 | hfE | 150 135 — 135 200 300 450 | 900 270 400 600 900 | - |
| Collector-Emitter Saturation Voltage (IC = 20 mAdc, IB = 2.0 mAdc) | | VCE(sat) | | 0.3 | Vdc |
| Base-Emitter On Voltage (IC = 0.5 mAdc, VCE = 3.0 Vdc) | | V _{BE(on)} | 0.5 | 0.65 | Vdc |
| SMALL SIGNAL CHARACTERISTICS | | 1 1 | | , | 1 |
| Current-Gain — Bandwidth Product (IC = 1.0 mAdc, VCE = 6.0 Vdc, f = 100 MHz) | | fτ | 75 | | MHz |

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 50 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 100 | mAdo |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | Tstg | 150 | °C |
| *Thermal Resistance Junction to Ambient | Reja | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBA812M3,4,5,6,7

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

Refer to 2N5086 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|---|----------------------|-------------------------------|---------------------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector Cutoff Current (VCB = 40 Vdc, IE = 0) | | СВО | | 0.1 | μAdc |
| Emitter Cutoff Current (VEB = 5.0 Vdc, IC = 0) | | IEBO | | 0.1 | μAdc |
| ON CHARACTERISTICS | | | | | L |
| DC Current Gain (VCE = 6.0 Vdc, I _C = 1.0 mAdc) | MMBA812M3 MMBA812M4 MMBA812M6 MMBA812M6 MMBA812M7 | hFE | 60 90 135 200 300 | 120 180 270 400 600 | |
| Collector-Emitter Saturation Voltage (IC = 30 mAdc, IB = 3.0 mAdc) | | V _{CE(sat)} | _ | 0.5 | Vdc |
| Base-Emitter On Voltage (VCE = 6.0 Vdc, IC = 1.0 mAdc) | | V _{BE(on)} | _ | 0.8 | Vdc |

MMBC1009F1 thru MMBC1009F5

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

AM/FM RF AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 25 | Vdc |
| Collector-Base Voltage | V _{CBO} | 50 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 50 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/℃ |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | Raja | 357 | •cw |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|--|------------------|-----------------------------|------------------|-------------------------------|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector Cutoff Current (VCB = 15 Vdc, I _E = 0) | | ГСВО | _ | _ | 0.1 | μAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain (I _C = 0.5 mAdc, V _{CE} = 3.0 Vdc) | MMBC1009F1 MMBC1009F2 MMBC1009F3 MMBC1009F4 MMBC1009F5 | hFE | 30 40 60 90 135 | - - - - | 60 80 120 180 270 | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | | VCE(sat) | _ | | 0.3 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product (IC = 1.0 mAdc, VCE = 6.0 Vdc, f = 100 N | 1Hz) | fτ | 150 | _ | _ | MHz |
| Output Capacitance (VCB = 6.0 Vdc, !E = 0, f = 1.0 MHz) | | C _{obo} | _ | 2.0 | | pF |
| Noise Figure (IC = 0.5 mAdc, VCE = 6.0 Vdc, f = 1.0 M | Hz, $R_G = 500 \Omega$ | NF | _ | 2.5 | - | dB |

| INDAMINON NATINGS | | | |
|--------------------------------|--------|-------|------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 25 | Vdc |
| Collector-Base Voltage | VCBO | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | Ic | 10 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | RAJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBC1321Q2 thru MMBC1321Q5

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

VHF/RF AMPLIFIER TRANSISTOR

NPN SILICON

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------------------|-----------------------|-------------|-------------------------|------|
| OFF CHARACTERISTICS | | | • | | |
| Collector Cutoff Current (VCB = 25 Vdc, IE = 0) | ICBO | _ | _ | 0.1 | μAdc |
| Emitter Cutoff Current (VEB = 4.0 Vdc, IC = 0) | lEBO | _ | _ | 0.1 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 2.0 mAdc, VCE = 6.0 Vdc) MMBC1321Q2 MMBC1321Q3 MMBC1321Q4 MMBC1321Q5 | hFE | 40 60 90 135 | - - - | 80 120 180 270 | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | V _{CE(sat)} | _ | _ | 0.6 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 2.0 mAdc, VCE = 6.0 Vdc, f = 100 MHz) | ίτ | 600 | _ | - | MHz |
| Output Capacitance (V _{CB} = 6.0 Vdc, I _E = 0, f = 100 MHz) | C _{obo} | _ | 1.3 | 1.8 | · pF |
| Noise Figure (VcF = 6.0 Vdc, IF = 2.0 mAdc, f = 900 MHz, RG = 50 Ω) | NF | | 5.0 | _ | dB |

MMBC1621B2,3,4

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| *************************************** | | | |
|---|--------|-------|------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Base Voltage | VCBO | 25 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | !c | 200 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW/°C |
| Storage Temperature | T _{stg} | 150 | ℃ |
| *Thermal Resistance Junction to Ambient | RAJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | | Symbol | Min | Max | Unit |
|--|--|----------------------|----------------|------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 100 μA) | | V(BR)CES | 20 | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μA) | | V(BR)CBO | 25 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μA) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 15 V) | | ІСВО | _ | 100 | nA |
| Emitter Cutoff Current (VEB = 4.0 V) | | EBO | _ | 100 | nA |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 1.0 mA, V _{CE} = 0.5 V) (I _C = 1.0 mA, V _{CE} = 0.5 V) (I _C = 1.0 mA, V _{CE} = 0.5 V) | MMBC1621B2 MMBC1621B3 MMBC1621B4 | hFE | 40 60 90 | 80 120 180 | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mA, Ig = 1.0 mA) | | V _{CE(sat)} | - | 0.25 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mA, Ig = 1.0 mA) | | V _{BE(sat)} | _ | 0.85 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | • | |
| Current-Gain — Bandwidth Product (IC = 10 mA, VCE = 10 V, f = 100 MHz) | | fΤ | 200 | _ | MHz |
| Output Capacitance (VCB = 10 V, f = 1.0 MHz) | | C _{obo} | _ | 5.0 | pF |
| SWITCHING CHARACTERISTICS | | | | | |
| Storage Time (I _C = I_{B1} = I_{B2} = 10 mA) (Figure 1) | | t _S | _ | 20 | ns |
| Turn-On Time (I _C = 10 mA, I _{B1} = 3.0 mA, V _{OB} = 1.5 V) | | ton | | 20 | ns |
| Turn-Off Time (IC = 10 mA, IB1 = 3.0 mA, IB2 = 1.5 mA) | | toff | _ | 40 | ns |

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 35 | Vdc |
| Collector-Base Voltage | V _{CBO} | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 100 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | ROJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBC1622D6,7,8

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MPS3904 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|---|---------------------|--------------------------|-----------------------|------|
| OFF CHARACTERISTICS | | | | <u> </u> | |
| Collector Cutoff Current (VCB = 25 Vdc, IE = 0) | | ICBO | | 50 | nAdc |
| Emitter Cutoff Current (VEB = 5.0 Vdc, IC = 0) | | IEBO | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | · · · · · · | • | |
| DC Current Gain (VCE = 3.0 Vdc, IC = 0.1 mAdc) (VCE = 3.0 Vdc, IC = 0.5 mAdc) | All MMBC1622D6 MMBC1622D7 MMBC1622D8 | hFE | 150 200 300 450 | 400 600 900 | _ |
| Collector-Emitter Saturation Voltage (IC = 100 mAdc, Ig = 10 mAdc) | | VCE(sat) | _ | 0.3 | Vdc |
| Base-Emitter On Voltage (VCE = 3.0 Vdc, IC = 0.5 mAdc) | | V _{BE(on)} | 0.55 | 0.65 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | <u> </u> | |
| Current-Gain — Bandwidth Product (VCE = 6.0 Vdc, I _E = 1.0 mAdc, f = 100 Mhz) | | ſī. | 100 | _ | MHz |

MMBC1623L3,4,5,6,7

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 50 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | Ic | 100 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stq} | 150 | °C |
| *Thermal Resistance Junction to Ambient | RAJA | 357 | •c/w |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

Refer to MPS3904 for graphs.

| Characteristic | | Symbol | Min | Max_ | Unit |
|--|--|----------------------|-------------------------------|---------------------------------|---------------|
| OFF CHARACTERISTICS | | | | | , |
| Collector Cutoff Current (VCB = 40 Vdc, IE = 0) | | 1CBO | - | 100 | nAdc |
| Emitter Cutoff Current (VEB = 5.0 Vdc, I _C = 0) | | lEBO | _ | 100 | nAdc |
| ON CHARACTERISTICS | | | | · | |
| DC Current Gain (IC = 1.0 mAdc, VCE = 6.0 Vdc) | MMBC1623L3 MMBC1623L4 MMBC1623L5 MMBC1623L6 MMBC1623L7 | hFE | 60 90 135 200 300 | 120 180 270 400 600 | _ |
| Collector-Emitter Saturation Voltage (IC = 100 mAdc, Ig = 10 mAdc) | | VCE(sat) | _ | 0.3 | Vdc |
| Base-Emitter Saturation Voltage (IC = 100 nAdc, IB = 10 mAdc) | | V _{BE(sat)} | _ | 1.0 | Vdc |
| Base-Emitter On Voltage (IC = 1.0 mAdc, VCE = 6.0 Vdc) | | V _{BE(on)} | .60 | 0.7 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | ,, |
| Current-Gain — Bandwidth Product (VCE = 6.0 Vdc, I _E = 10 mAdc, f = 100 MHz) | | fτ | 200 | - | MHz |

| WANTED IN THE | | | |
|--------------------------------|------------------|-------|------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 130 | Vdc |
| Collector-Base Voltage | V _{CBO} | 150 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc lc | 50 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | Raja | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBC1653N2,3,4

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

HIGH VOLTAGE TRANSISTOR

NPN SILICON

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|--|----------------------|------------------|-----|-------------------|---------|
| OFF CHARACTERISTICS | | | | | | |
| Collector Cutoff Current (VCB = 100 Vdc, lg = 0) | | Ісво | _ | _ | 0.1 | μAdc |
| Emitter Cutoff Current (VEB = 5.0 Vdc, IC = 0) | | EBO | _ | _ | 0.1 | μAdc |
| ON CHARACTERISTICS | | | | · | · | |
| DC Current Gain (VCE = 3.0 Vdc, IC = 15 mAdc) | MMBC1653N2 MMBC1653N3 MMBC1653N4 | hFE | 50 100 150 | = | 130 220 330 | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | | VCE(sat) | _ | _ | 0.5 | Vđc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | | V _{BE(sat)} | | _ | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | • | | 1 | | · |
| Current-Gain — Bandwidth Product (VCE = 10 Vdc, IF = 10 mAdc, f = 100 MHz) | | fT | - | 150 | _ | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, l _E = 0, f = 1.0 MHz) | | C _{obo} | - | 4.5 | - | pF |

MMBC1654N5,6,7

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

HIGH VOLTAGE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| mounten iorintee | | | |
|--------------------------------|--------|-------|------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 160 | Vdc |
| Collector-Base Voltage | VCBO | 180 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 50 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW/°C |
| Storage Temperature | T _{stg} | 150 | •€ |
| *Thermal Resistance Junction to Ambient | RAJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|--|----------------------|------------------|-----|-------------------|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector Cutoff Current (VCB = 100 V, IE = 0) | | ІСВО | _ | - | 0.1 | μAdc |
| Emitter Cutoff Current (VEB = 5.0 Vdc, IC = 0) | | IEBO | _ | _ | 0.1 | μAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain (VCE = 3.0 V, I _C = 15 mAdc) | MMBC1654N5 MMBC1654N6 MMBC1654N7 | hFE | 50 100 150 | 111 | 130 220 330 | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | | V _{CE(sat)} | _ | - | 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | | VBE(sat) | _ | 1 | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product (VCE = 10 Vdc, IF = 10 mAdc, f = 100 MHz) | | fT | _ | 150 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | | Сово | _ | 4.5 | _ | pF |

| Rating | Symbol | Value | Unit |
|-----------------|--------|-------|------|
| Reverse Voltage | VR | 4.0 | Vdc |

THERMAL CHARACTERISTICS

| THE THINK OF THE THE THE | 10 110 | | |
|---|------------------|------------|-------------|
| Characteristic | Symbol | Max | Unit |
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | $R_{\theta JA}$ | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBD101

CASE 318-02/03, STYLE 8 SOT-23 (TO-236AA/AB)

> HOT-CARRIER UHF MIXER DIODE

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|-------------------|-----|----------|-------|----------|
| OFF CHARACTERISTICS | | | | TIAL | pant and |
| Reverse Breakdown Voltage (I _R = 10 µAdc) | V _(BR) | 4.0 | | E A V | Vdc |
| Reverse Voltage Leakage Current (V _R = 3.0 Vdc) | IR | - 1 | MARK ALL | 0.25 | μAdc |
| Series Inductance (f = 250 MHz) | LS | - | 6.0 | | nH |
| Case Capacitance (f = 1.0 MHz) | СС | | 0.18 | - | pF |
| Diode Capacitance (V _R = 0, f = 1.0 MHz) | СТ | | _ | 1.0 | pF |
| Forward Voltage (I _F = 10 mAdc) | VF | - | _ | 0.60 | Vdc |
| Noise Figure (f = 1.0 GHz) | NF | - | - | 7.0 | dB |

CASE 318-02/03 STYLE 11 SOT-23 (TO-236AA/AB)

DUAL HOT CARRIER MIXER DIODE

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|----------------------------|--------|-------|------|
| Continuous Reverse Voltage | VR | 4 | Vcc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stq} | 150 | °C |
| *Thermal Resistance Junction to Ambient | | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | Symbol | Min | Max | Unit |
|---|----------------|-----|------------|------|
| OFF CHARACTERISTICS | | | 1 | |
| Forward Voltage (IF = 10 mA) | VF | | 0.60 | ٧ |
| Reverse Voltage Leakage Current (V _R = 3.0 V) (V _R = 4.0 V) | I _R | _ | 0.25 10 | μА |
| Capacitance (V _R = 0 V, f = 1.0 MHz) | С | | 1.0 | pF |

CASE 318-02/03, STYLE 8 SOT-23 (TO-236AA/AB)

HOT-CARRIER DIODE

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|-----------------|--------|-------|------|
| Reverse Voltage | ٧R | 50 | Vdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| •Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | ROJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|-------------------|-----|----------|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Reverse Breakdown Voltage (I _R = 10 μAdc) | V _(BR) | 50 | _ | | Vdc |
| Reverse Voltage Leakage Current (VR = 25 Vdc) | IR | _ | _ | 200 | μAdc |
| Diode Capacitance (V _R = 20 Vdc, f = 1.0 MHz) | CT | _ | _ | 1.0 | pF |
| Forward Voltage (IF = 10 mAdc) | V _F | _ | - | 1.2 | Vdc |

CASE 318-02/03, STYLE 8 SOT-23 (TO-236AA/AB)

HIGH-SPEED SWITCHING DIODE

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|----------------------------|----------------|-------|------|
| Reverse Voltage | V _R | 70 | Vdc |
| Forward Current | lF | 200 | mAdc |
| Peak Forward Surge Current | IFM(surge) | 500 | mAdc |

THERMAL CHARACTERISTICS

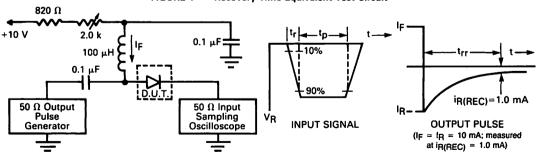
| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|---|-------------------|-----|-----------|--------------|
| OFF CHARACTERISTICS | - | | | |
| Reverse Breakdown Voltage (I _R = 100 μAdc) | V _(BR) | 100 | _ | Vdc |
| Reverse Voltage Leakage Current (V _R = 20 Vdc) (V _R = 75 Vdc) | IR | = | 25 5.0 | nAdc µAdc |
| Diode Capacitance (VR = 0 Vdc, f = 1.0 MHz) | c _T | _ | 4.0 | pF |
| Forward Voltage (IF = 10 mAdc) | VF | _ | 1.0 | Vdc |
| Reverse Recovery Time (!F = I _R = 10 mAdc) (Figure 1) | t _{rr} | _ | 4.0 | ns |

FIGURE 1 — Recovery Time Equivalent Test Circuit



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.

- 2. Input pulse is adjusted so IR(peak) is equal to 10 mA.
- 3. tp = trr

| Rating | Symbol | Value | Unit |
|-----------------|----------------|-------|------|
| Reverse Voltage | V _R | 70 | Vdc |
| Forward Current | l _E | 100 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBD2835,36

CASE 318-02/03, STYLE 12 SOT-23 (TO-236AA/AB)

> **DUAL SWITCHING DIODE**

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|---|----------------------|-------------------|----------|-------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Reverse Breakdown Voltage (I _R = 100 μAdc) | MMBD2835 MMBD2836 | V _(BR) | 35 75 | = | Vdc |
| Reverse Voltage Leakage Current (V _R = 30 Vdc) (V _R = 50 Vdc) | MMBD2835 MMBD2836 | IR | 1-1 | 100 100 | nAdc |
| Diode Capacitance (V _R = 0, f = 1.0 MHz) | | СТ | - | 4.0 | pF |
| Forward Voltage (IF = 10 mAdc) (IF = 50 mAdc) (IF = 100 mAdc) | | VF | | 1.0 1.0 1.2 | Vdc |
| Reverse Recovery Time (IF = IR = 10 mAdc, iR(REC) = 1.0 mAdc) (Figure 1) | | t _{rr} | _ | 6.0 | ns |

FIGURE 1 — Recovery Time Equivalent Test Circuit 100 дН 🗲 L_{10%} iR(REC) = 1.0 mA50 Ω Input Sampling ٧R INPUT SIGNAL Oscilloscope **OUTPUT PULSE**

Notes: 1. A 2.0 k Ω variable resistor adjusted for a Forward Current (IF) of 10 mA.

2. Input pulse is adjusted so IR(peak) is equal to 10 mA.

3. tp » trr

820 Ω

50 Ω Output

Pulse

Generator

2.Ó k

0.1 µF

+10 V

(lp = lp = 10 mA; measured at $i_{R(REC)} = 1.0 \text{ mA}$

MMBD2837 MMBD2838

CASE 318-02/03, STYLE 9 SOT-23 (TO-236AA/AB)

DUAL SWITCHING DIODE

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|--------|------------|------|
| Peak Reverse Voltage | VRM | 75 | Vdc |
| D.C. Reverse Voltage MMBD2837 MMBD2838 | VR | 30 50 | Vdc |
| Peak Forward Current | IFM | 450 300 | mAdc |
| Average Rectified Current | lo | 150 100 | mAdo |

THERMAL CHARACTERISTICS

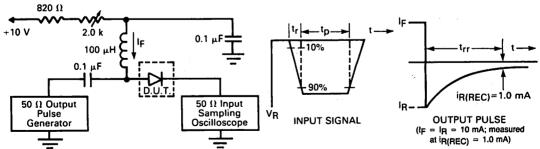
| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | ပ္ |
| *Thermal Resistance Junction to Ambient | RøJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|---|----------------------|-------------------|-------------|-------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Reverse Breakdown Voltage (I(BR) = 100 μAdc) | MMBD2837 MMBD2838 | V _(BR) | 35 75 | _ | Vdc |
| Reverse Voltage Leakage Current (VR = 30 Vdc) (VR = 50 Vdc) | MMBD2837 MMBD2838 | ¹ R | _ | 0.1 0.1 | μAdc |
| Diode Capacitance (V _R = 0, f = 1.0 MHz) | | Ст | - | 4.0 | pF |
| Forward Voltage (It = 10 mAdc) (It = 50 mAdc) (It = 100 mAdc) | | VF | _ _ _ | 1.0 1.0 1.2 | Vdc |
| Reverse Recovery Time (I _F = I _R = 10 mAdc, i _R (REC) = 1.0 mAdc) (Figure 1) | | trr | _ | 6.0 | ns |

FIGURE 1 — Recovery Time Equivalent Test Circuit



Notes: 1. A 2.0 k $\!\Omega$ variable resistor adjusted for a Forward Current (IF) of 10 mA.

- 2. Input pulse is adjusted so IR(peak) is equal to 10 mA.
- 3. tp = trr

| Rating | Symbol | Value | Unit |
|----------------------------|----------------|-------|------|
| Reverse Voltage | V _R | 70 | Vdc |
| Forward Current | ΙF | 200 | mAdc |
| Peak Forward Surge Current | IFM(surge) | 500 | mAdc |

THERMAL CHARACTERISTICS

| THE INVAL OF MANAGE ENGINEE | | | |
|---|------------------|------------|-------------|
| Characteristic | Symbol | Max | Unit |
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | RAJA | 357 | •c/w |

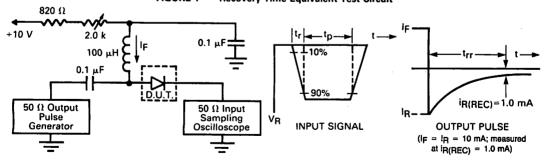
^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBD6050

CASE 318-02/03, STYLE 8 SOT-23 (TO-236AA/AB) SWITCHING DIODE

| Characteristic | Symbol | Min | Max | Unit |
|--|-----------------|--------------|------------|------|
| OFF CHARACTERISTICS | | • | | |
| Reverse Breakdown Voltage (I(BR) = 100 µAdc) | V(BR) | 70 | - | Vdc |
| Reverse Voltage Leakage Current (V _R = 50 Vdc) | I _R | _ | 0.1 | μAdc |
| Forward Voltage (IF = 1.0 mAdc) (IF = 100 mAdc) | VF | 0.55 0.85 | 0.7 1.1 | Vdc |
| Reverse Recovery Time (IF = IR = 10 mAdc, iR(REC) = 1.0 mAdc) (Figure 1) | t _{rr} | _ | 10 | ns |
| Capacitance (V _R = 0) | С | _ | 2.5 | pF |





- Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (Ip) of 10 mA.
 - 2. Input pulse is adjusted so IR(peak) is equal to 10 mA.
 - 3. tp = trr

CASE 318-02/03, STYLE 9 SOT-23 (TO-236AA/AB)

> DUAL SWITCHING DIODE

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|----------------------------|----------------|-------|------|
| Reverse Voltage | V _R | 70 | Vdc |
| Forward Current | lF | 200 | mAdc |
| Peak Forward Surge Current | IFM(surge) | 500 | mAdc |

THERMAL CHARACTERISTICS

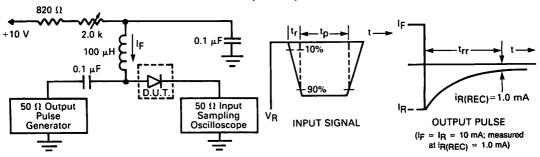
| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|--|-------------------|--------------|------------|------|
| OFF CHARACTERISTICS | | | | |
| Reverse Breakdown Voltage (I _{{BR})} = 100 μAdc) | V _(BR) | 70 | _ | Vdc |
| Reverse Voltage Leakage Current (V _R = 50 Vdc) | l _R | _ | 0.1 | μAdc |
| Forward Voltage (IF = 1.0 mAdc) (IF = 100 mAdc) | VF | 0.55 0.85 | 0.7 1.1 | Vdc |
| Reverse Recovery Time (IF = IR = 10 mAdc, IR(REC) = 1.0 mAdc) (Figure 1) | t _{rr} | _ | 15 | ns |
| Capacitance (V _R = 0) | С | _ | 2.5 | pF |

FIGURE 1 — Recovery Time Equivalent Test Circuit



- Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (IF) of 10 mA.
 - 2. Input pulse is adjusted so IR(peak) is equal to 10 mA.
 - 3. tp * trr

| Rating | Symbol | Value | Unit |
|----------------------------|------------|-------|------|
| Reverse Voltage | VR | 100 | Vdc |
| Forward Current | lF | 200 | mAdc |
| Peak Forward Surge Current | [FM(surge) | 500 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | Tstg | 150 | °C |
| *Thermal Resistance Junction to Ambient | Reja | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBD7000

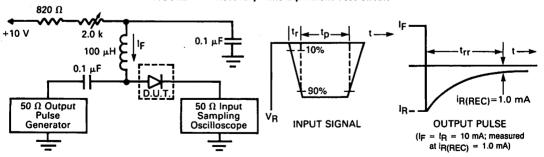
CASE 318-02/03, STYLE 11 SOT-23 (TO-236AA/AB)

DUAL SWITCHING DIODE

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|--|--|----------------------|--------------------|------|
| OFF CHARACTERISTICS | | | | |
| Reverse Breakdown Voltage (I _(BR) = 100 µAdc) | V(BR) | 100 | _ | Vdc |
| Reverse Voltage Leakage Current (V _R = 50 Vdc) (V _R = 100 Vdc) (V _R = 50 Vdc, 125°C) | ¹ R ¹ R2 ¹ R3 | _ | 0.30 0.5 100 | μAdc |
| Forward Voltage (IF = 1.0 mAdc) (IF = 10 mAdc) (IF = 100 mAdc) | VF | 0.55 0.67 0.75 | 0.7 0.82 1.1 | Vdc |
| Reverse Recovery Time (IF = IR = 10 mAdc) (Figure 1) | t _{rr} | - | 15 | ns |
| Capacitance (V _R = 0) | С | _ | 1.5 | pF |

FIGURE 1 — Recovery Time Equivalent Test Circuit



- Notes: 1. A 2.0 k Ω variable resistor adjusted for a Forward Current (IF) of 10 mA.
 - 2. Input pulse is adjusted so In(peak) is equal to 10 mA.
 - 3. tp = trr

MMBF4391 thru MMBF4393

CASE 318-02/03, STYLE 10 SOT-23 (TO-236AA/AB)

JFET SWITCHING TRANSISTOR

N-CHANNEL

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|----------------------|-----------------|-------|------|
| Drain-Source Voltage | V _{DS} | 30 | Vdc |
| Drain-Gate Voltage | V _{DG} | 30 | Vdc |
| Gate-Source Voltage | V _{GS} | 30 | Vdc |
| Forward Gate Current | lG(f) | 50 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | Tstg | 150 | •℃ |
| *Thermal Resistance Junction to Ambient | ReJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | | Symbol | Min | Max | Unit |
|---|----------------------------------|------------------|-------------------|-------------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (IG = 1.0 µAdc, VDS = 0) | | V(BR)GSS | 30 | _ | Vdc |
| Gate Reverse Current (VGS = 15 Vdc, VDS = 0, TA = 25°C) (VGS = 15 Vdc, VDS = 0, TA = 100°C) | | 1GSS | _ | 1.0 0.20 | nAdc μAdc |
| Gate Source Cutoff Voltage (VDS = 15 Vdc, ID = 10 nAdc) | MMBF4391 MMBF4392 MMBF4393 | VGS(off) | 4.0 2.0 0.5 | 10 5.0 3.0 | Vdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain (VDS = 15 V, VGS = 0) | MMBF4391 MMBF4392 MMBF4393 | IDSS | 50 25 5.0 | 150 75 30 | mAdc |
| Drain Current (VDS = 15 Vdc, VGS = 12 Vdc) (VDS = 15, VGS = 12 Vdc, TA = 100°C) | | ο | = | 1.0 1.0 | nAdc μAdc |
| Drain-Source On-Voltage (ID = 12 mAdc, VGS = 0) (ID = 6.0 mAdc, VGS = 0) (ID = 3.0 mAdc, VGS = 0) | MMBF4391 MMBF4392 MMBF4393 | VDS(on) | = | 0.4 0.4 0.4 | Vdc |
| Static Drain-Source On Resistance (I _D = 1.0 mAdc, V _{GS} = 0) | MMBF4391 MMBF4392 MMBF4393 | 「DS(on) | <u>-</u> | 30 60 100 | Ohms |
| SMALL-SIGNAL CHARACTERISTICS | | <u>-</u> | | | |
| Input Capacitance (VDS = 15 Vdc, VGS = 0, f = 1.0 MHz) | | C _{iss} | _ | 14 | pF |
| Reverse Transfer Capacitance (VDS = 0, VGS = 12 Vdc, f = 1.0 MHz) | | C _{rss} | _ | 3.5 | pF |

| Rating | Symbol | Value | Unit |
|----------------------|-----------------|-------|------|
| Drain-Source Voltage | V _{DS} | 30 | Vdc |
| Drain-Gate Voltage | V _{DG} | 30 | Vdc |
| Gate-Source Voltage | V _{GS} | 30 | Vdc |
| Gate Current | l _G | 10 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | P,D | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | RAJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBF4416

CASE 318-02/03, STYLE 10 SOT-23 (TO-236AA/AB)

FET
VHF/UHF AMPLIFIER TRANSISTOR
N-CHANNEL

| Characteristic | Symbol | Min | Max | Unit |
|--|------------------|----------------|------------|--------------|
| OFF CHARACTERISTICS | | | | |
| Gate-Source Breakdown Voltage (IG = 1.0 µAdc, VDS = 0) | V(BR)GSS | 30 | | Vdc |
| Gate Reverse Current (VGS = 20 Vdc, VDS = 0) (VGS = 20 Vdc, VDS = 0, TA = 150°C) | ¹ GSS | _ | 100 200 | pAdc nAdc |
| Gate Source Cutoff Voltage (Ip = 1.0 nAdc, Vps = 15 Vdc) | VGS(off) | _ | 6.0 | Vdc |
| Gate Source Voltage (Ip = 0.5 mAdc, Vps = 15 Vdc) | V _G S | 1.0 | 5.5 | Vdc |
| ON CHARACTERISTICS | | | | |
| Zero-Gate-Voltage Drain (VGS = 15 Vdc, VGS = 0) | IDSS | 5.0 | 15 | mAdc |
| Gate-Source Forward Voltage (IG = 1.0 mAdc, VDS = 0) | VGS(f) | . - | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Forward Transfer Admittance (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz) | Y _{fs} | 4500 | 7500 | μmhos |
| Output Admittance (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz) | lyosl | _ | 50 | μmhos |
| Input Capacitance (VDS = 15 Vdc, VGS = 0, f = 1.0 MHz) | C _{iss} | _ | 4.0 | pF |
| Reverse Transfer Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz) | C _{rss} | _ | 0.8 | pF |
| Output Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz) | C _{oss} | | 2.0 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | |
| Noise Figure | NF | | | dB |
| $(V_{DS} = 15 \text{ Vdc}, I_{D} = 5.0 \text{ mAdc}, R_{g} \approx 1000 \Omega, f = 100 \text{ MHz})$ $(V_{DS} = 15 \text{ Vdc}, I_{D} = 5.0 \text{ mAdc}, R_{g} \approx 1000 \Omega, f = 400 \text{ MHz})$ | | _ | 2.0 4.0 | |
| Common Source Power Gain (V _{DS} = 15 Vdc, I _D = 5.0 mAdc, f = 100 MHz) (V _{DS} = 15 Vdc, I _D = 5.0 mAdc, f = 400 MHz) | G _{ps} | 18 10 | = | dB |

MMBF4860

CASE 318-02/03, STYLE 10 SOT-23 (TO-236AA/AB)

FET SWITCHING TRANSISTOR

N-CHANNEL

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|-----------------------------|--------------------|-------|------|
| Drain-Source Voltage | VDS | 30 | Vdc |
| Drain-Gate Voltage | VDG | 30 | Vdc |
| Reverse Gate-Source Voltage | V _{GS(r)} | 30 | Vdc |
| Forward Gate Current | l _{G(f)} | 50 | mAdc |

THERMAL CHARACTERISTICS

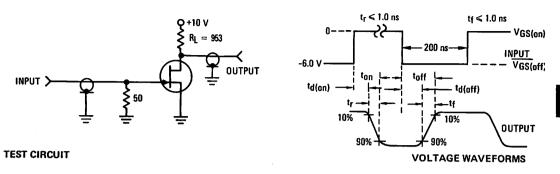
| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | ReJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x x 0.6 mm.

| Characteristic | Symbol | Min | Max | Unit |
|--|---------------------|-----|-------------|--------------|
| OFF CHARACTERISTICS | | | | |
| Gate-Source Breakdown Voltage (I _G = 1.0 µAdc, V _{DS} = 0) | V(BR)GSS | 30 | _ | Vdc |
| Gate Reverse Current (VGS = 15 Vdc, V _{DS} = 0) (VGS = 15 Vdc, V _{DS} = 0, T _A = 150°C) | IGSS | = | 0.5 2.0 | nAdc μAdc |
| Gate Source Cutoff Voltage (V _{DS} = 15 Vdc, l _D = 0.5 nAdc) | VGS(off) | 2.0 | 6.0 | Vdc |
| ON CHARACTERISTICS | | | _ | |
| Zero-Gate-Voltage Drain(1) (VDS = 15 Vdc, VGS = 0) | IDSS | 20 | 100 | mAdc |
| Drain Cutoff Current (VDS = 15 Vdc, VGS = 10 Vdc) (VDS = 15 Vdc, VGS = 10 Vdc, T _A = 150°C) | ^I D(off) | | 0.25 0.5 | nAdc μAdc |
| Drain-Source On-Voltage (I _D = 10 mAdc, V _{GS} = 0) | V _{DS(on)} | _ | 0.5 | Vdc |
| Static Drain-Source On Resistance (VGS = 0, I _D = 0, f = 1.0 kHz) | fDS(on) | _ | 40 | Ohms |
| Input Capacitance (Vps = 0, Vgs = 10 Vdc, f = 1.0 MHz) | C _{iss} | _ | 18 | pF |
| Reverse Transfer Capacitance (V _{DS} = 0, V _{GS} = 10 Vdc, f = 1.0 MHz) | C _{rss} | _ | 8.0 | pF |
| SWITCHING CHARACTERISTICS | | | | |
| Delay Time (V _{DD} = 10 Vdc, I _{D(on)} = 20 mAdc) (V _{G(on)} = 0, V _{GS(off)} = 10 Vdc) | ^t d | - | 6.0 | ns |
| Rise Time (V _{DD} = 10 Vdc, I _{D(on)} = 10 mAdc) (V _{GS(on)} = 0, V _{GS(off)} = 6.0 Vdc) (Figure 1) | t _r | _ | 4.0 | ns |
| Turn-Off Time (V _{DD} = 10 Vdc, I _{D(on)} = 5.0 mAdc) (V _{GS(on)} = 0. V _{GS(off)} = 4.0 Vdc) (Figure 1) | ^t off | _ | 50 | ns |

⁽¹⁾ Pulse Test: Pulse Width = 100 ms, Duty Cycle ≤ 10%.

FIGURE 1 - SWITCHING TIMES TEST CIRCUIT



NOTES: 1. The input waveforms are supplied by a generator with the following characteristics: $Z_{out} = 50$ ohms, Duty Cycle $\sim 2.0\%$

2. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \le 0.75$ ns, $R_{in} \ge 1.0$ megohm, $C_{in} \le 2.5$ pF.

MMBF5457

CASE 318-02/03, STYLE 10 SOT-23 (TO-236AA/AB)

FET GENERAL PURPOSE TRANSISTOR N-CHANNEL

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|-----------------------------|--------------------|-------|------|
| Drain-Source Voltage | VDS | 25 | Vdc |
| Drain-Gate Voltage | V _{DG} | 25 | Vdc |
| Reverse Gate-Source Voltage | V _{GS(r)} | 25 | Vdc |
| Gate Current | l _G | 10 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|------------------|----------|-----|------------|-------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (IG = 10 µAdc, VDS = 0) | V(BR)GSS | 25 | _ | _ | Vdc |
| Gate Reverse Current (VGS = 15 Vdc, VDS = 0) (VGS = 15 Vdc, VDS = 0, TA = 100°C) | IGSS | _ _ | | 1.0 200 | nAdc |
| Gate Source Cutoff Voltage (Vps = 15 Vdc, lp = 10 nAdc) | VGS(off) | 0.5 | _ | 6.0 | Vdc |
| Gate Source Voltage (V _{DS} = 15 Vdc, I _D = 100 μAdc) | VGS | _ | 2.5 | | Vdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain(1) (VDS = 15 Vdc, VGS = 0) | IDSS | 1.0 | _ | 5.0 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transfer Admittance(1) (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 kHz) | Y _{fs} | 1000 | _ | 5000 | μmhos |
| Reverse Transfer Admittance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 kHz) | lyrsl | _ | 10 | 50 | μmhos |
| Input Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz) | C _{iss} | _ | 4.5 | 7.0 | pF |
| Reverse Transfer Capacitance (VDS = 15 Vdc, VGS = 0, f = 1.0 MHz) | C _{rss} | _ | 1.5 | 3.0 | pF |

⁽¹⁾ Pulse test: Pulse Width < 630 ms; Duty Cycle ≤ 10%.

| Rating | Symbol | Value | Unit |
|-----------------------------|--------------------|-------|------|
| Drain-Gate Voltage | VDG | 25 | Vdc |
| Reverse Gate-Source Voltage | V _{GS(r)} | - 25 | Vdc |
| Gate Current | IG | 10 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | Tstg | 150 | °C |
| *Thermal Resistance Junction to Ambient | RøJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBF5459

CASE 318-02/03, STYLE 10 SOT-23 (TO-236AA/AB)

FET TRANSISTOR

N-CHANNEL

| Characteristic | Symbol | Min | Max | Unit |
|---|-------------------|------|------|-------|
| OFF CHARACTERISTICS | | | | |
| Gate-Source Breakdown Voltage (I _G = -10 μA, V _{DS} = 0) | V(BR)GSS | 25 | _ | Vdc |
| Gete 1 Leakage Current (VGS = -15 V, VpS = 0) | l _{G1SS} | _ | 1.0 | -nA |
| Gate 2 Leakage Current (VGS = -15 V, VDS = 0, TA = 100°C) | l _{G2SS} | _ | 200 | nA |
| Gate Source Cutoff Voltage (Vps = 15 V, lp = 10 nA) | VGS(off) | 2.0 | 8.0 | Vdc |
| ON CHARACTERISTICS | • | _ | | |
| Zero-Gate-Voltage Drain (Vps = 15 V, Vgs = 0) | loss | 4.0 | 16 | mA |
| SMALL-SIGNAL CHARACTERISTICS | | | | • |
| Forward Transfer Admittance (V _{DS} = 15 V, V _{GS} = 0, f = 1.0 kHz) | Y _{fs} | 2000 | 6000 | μmhos |
| Output Admittance (Vps = 15 V, Vgs = 0, f = 1.0 kHz) | lyosl | _ | 50 | μmhos |
| Input Capacitance (VDS = 15 V, VGS = 0, f = 1.0 MHz) | C _{iss} | | 7.0 | pF |
| Reverse Transfer Capacitance (VDS = 15 V, VGS = 0, f = 1.0 MHz) | C _{rss} | | 3.0 | pF |

MMBF5460

CASE 318-02/03, STYLE 10 SOT-23 (TO-236AA/AB)

FET GENERAL PURPOSE TRANSISTOR

P-CHANNEL

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|-----------------------------|-----------------|-------|------|
| Drain-Gate Voltage | V _{DG} | 40 | Vdc |
| Reverse Gate-Source Voltage | VGSR | 40 | Vdc |
| Forward Gate Current | ^I GF | 10 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|------------------|------|-----|------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (IG = 10 μAdc, VDS = 0) | V(BR)GSS | 40 | _ | - | Vdc |
| Gate Reverse Current (VGS = 20 Vdc, VDS = 0) (VGS = 20 Vdc, VDS = 0, TA = 100°C) | Igss | 1 1 | _ | 5.0 1.0 | nAdc μAdc |
| Gate Source Cutoff Voltage (Vps = 15 Vdc, tp = 1.0 μAdc) | VGS(off) | 0.75 | _ | 6.0 | Vdc |
| Gate Source Voltage (Vps = 15 Vdc, lp = 0.1 mAdc) | V _{GS} | 0.5 | - | 4.0 | Vdc |
| ON CHARACTERISTICS | | | | · | |
| Zero-Gate-Voltage Drain (Vps = 15 Vdc, Vgs = 0) | IDSS | 1.0 | _ | 5.0 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transfer Admittance (Vps = 15 Vdc, Vgs = 0, f = 1.0 kHz) | Y _{fs} | 1000 | _ | 4000 | μmhos |
| Output Admittance (Vps = 15 Vdc, Vgs = 0, f = 1.0 kHz) | lyosi | - | | 75 | μmhos |
| Input Capacitance (Vps = 15 Vdc, V _{GS} = 0, f = 1.0 MHz) | C _{iss} | Ί | 5.0 | 7.0 | pF |
| Reverse Transfer Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz) | C _{rss} | _ | 1.0 | 2.0 | pF |
| Equivalent Short-Circuit Input Noise Voltage $(V_{DS}=15\ V_{dC},\ V_{GS}=0,\ R_{G}=1.0\ M\Omega,$ $f=100\ Hz,\ BW=1.0\ Hz)$ | ē _n | _ | 20 | _ | nV/√Hz |

| Rating | Symbol | Value | Unit |
|--|--------------------|-------------|-------------|
| Drain-Gate Voltage | VDG | 25 | Vdc |
| Reverse Gate-Source Voltage | V _{GS(r)} | 25 | Vdc |
| Forward Gate Current | lG(f) | 10 | mA |
| Continuous Device Dissipation at or Below TC = 25°C Linear Derating Factor | PD | 200 2.80 | mW mW/°C |
| Storage Channel Temperature Range | T _{sta} | -65 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | ဗ |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBF5484

CASE 318-02/03, STYLE 10 SOT-23 (TO-236AA/AB)

> FET TRANSISTOR

> > N-CHANNEL

| FI FCTRICAL | CHARACTERISTICS (TA = | 25°C unless otherwise noted.) |
|-------------|-----------------------|-------------------------------|
| | | |

| Characteristic | Symbol | Min | Max | Unit |
|---|---------------------------------------|-------------|----------------|---------------|
| OFF CHARACTERISTICS | | | | · · · · · · · |
| Gate-Source Breakdown Voltage (I _G = -1.0 μA, V _{DS} = 0) | V(BR)GSS | – 25 | _ | Vdc |
| Gate Reverse Current (VGS = -20 V, VDS = 0) (VGS = -20 V, VDS = 0, TA = 100°C) | lgss l | | - 1.0 - 0.2 | nΑ μΑ |
| Gate Source Cutoff Voltage (V _{DS} = 15 V, I _D = 10 nA) | VGS(off) | -0.3 | -3.0 | Vdc |
| ON CHARACTERISTICS | · · · · · · · · · · · · · · · · · · · | | | |
| Zero-Gate-Voltage Drain (VDS = 15 V, VGS = 0) | l _{DSS} | 1.0 | 5.0 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Forward Transfer Admittance (VDS = 15 V, VGS = 0, f = 1.0 kHz) | Y _{fs} | 3000 | 6000 | μmhos |
| Output Admittance (Vps = 15 V, Vgs = 0, f = 1.0 kHz) | lyosl | 1 | 50 | μmhos |
| Input Capacitance (VDS = 15 V, VGS = 0, f = 1.0 MHz) | C _{iss} | - | 5.0 | pF |
| Reverse Transfer Capacitance (VDS = 15 V, VGS = 0, f = 1.0 MHz) | C _{rss} | _ | 1.0 | pF |
| Output Capacitance (V _{DS} = 15 V, V _{GS} = 0, f = 1.0 MHz) | C _{oss} | _ | 2.0 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | |
| Noise Figure (VDS = 15 V, ID = 1.0 mA, YG' = 1.0 mmhos) (RG = 1.0 k Ω , f = 100 MHz) | NF | | 3.0 | dB |
| (NG = 1.0 kI, T = 100 MHz) (VDS = 15 V, VGS = 0, YG' = 1.0 μmho) (RG = 1.0 MΩ, f = 1.0 kHz) | | | 2.5 | |
| Common Source Power Gain (VDS = 15 Vdc, I_D = 1.0 mAdc, f = 100 MHz) | G _{ps} | 16 | 25 | dB |

MMBF5486

CASE 318-02/03, STYLE 10 SOT-23 (TO-236AA/AB)

FET TRANSISTOR

N-CHANNEL

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|-----------------------------|--------------------|-------|------|
| Drain-Gate Voltage | V _{DG} | 25 | Vdc |
| Reverse Gate-Source Voltage | V _{GS(r)} | 25 | Vdc |
| Forward Gate Current | IG(f) | 10 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|----------|-------------------|-------------|
| OFF CHARACTERISTICS | | | | |
| Gate-Source Breakdown Voltage (V _{DS} = 0, I _G = -1.0 μA) | V(BR)GSS | -25 | _ | Vdc |
| Gate 1 Leakage Current (VGS = -20 V, VDS = 0) | IG1SS | _ | -1.0 | пA |
| Gate 2 Leakage Current (VGS = -20 V, VDS = 0, TA = 100°C) | lG2SS | | -0.2 | μА |
| Gate Source Cutoff Voltage (VDS = 15 V, ID = 10 nA) | VGS(off) | - 2.0 | -6.0 | Vdc |
| ON CHARACTERISTICS | | | _ | |
| Zero-Gate-Voltage Drain (VGS = 0, V _{DS} = 15 V) | lDSS | 8.0 | 20 | mA |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Forward Transfer Admittance (VGS = 0, VDS = 15 V, f = 1.0 kHz) | lYfsl | 4000 | 8000 | μmhos |
| Input Admittance (VGS = 0, VDS = 15 V, f = 400 MHz) | Re(yis) | | 1000 | μmhos |
| Output Admittance (VGS = 0, VDS = 15 V, f = 1.0 kHz) | lyosl | _ | 75 | μπhos |
| Output Conductance (VGS = 0, VDS = 15 V, $f = 400 \text{ MHz}$) | Re(yos) | _ | 100 | μmhos |
| Forward Transconductance (VGS = 0, VDS = 15 V, f = 400 MHz) | Re(yfs) | 3500 | _ | μmhos |
| Input Capacitance (VGS = 0, VDS = 15 V, f = 1.0 MHz) | C _{iss} | _ | 5.0 | pF |
| Reverse Transfer Capacitance (VGS = 0, VDS = 15 V, f = 1.0 MHz) | C _{rss} | _ | 1.0 | pF |
| Output Capacitance (VGS = 0, VDS = 15 V, f = 1.0 MHz) | Coss | _ | 2.0 | pf |
| FUNCTIONAL CHARACTERISTICS | | | | |
| Noise Figure (VDS = 15 V, ID = 4.0 mA, f = 100 MHz, YG = 1.0 μmhos) (VDS = 15 V, ID = 4.0 mA, RG = 1.0 kΩ, f = 400 MHz, YG = 1.0 μmhos) (VGS = 0, VDS = 15 V, RG = 1.0 mΩ, f = 1.0 kHz, YG = 1.0 μmhos) | NF | | 2.0 4.0 2.5 | dB |
| Common Source Power Gain (VDS = 15 V, ID = 4.0 mA, f = 100 MHz) (VDS = 15 V, ID = 4.0 mA, f = 400 MHz) | Gps | 18 10 | 30 20 | dB |

| Rating | Symbol | Value | Unit |
|----------------------|-----------------|-------|------|
| Drain-Source Voltage | V _{DS} | 25 | Vdc |
| Gate-Source Voltage | V _{GS} | 25 | Vdc |
| Gate Current | le le | 10 | mAdc |

THERMAL CHARACTERISTICS

| THE MINE OF INTROTEMOTIO | | | |
|---|------------------|------------|-------------|
| Characteristic | Symbol | Max | Unit |
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | Reja | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBFJ310

CASE 318-02/03, STYLE 10 SOT-23 (TO-236AA/AB)

> FET VHF/UHF AMPLIFIER TRANSISTOR

> > N-CHANNEL

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|--------------------|------|-----|----------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (IG = -1.0 µAdc, VDS = 0) | V(BR)GSS | - 25 | _ | _ | Vdc |
| Gate Reverse Current (VGS = -15 V) (VGS = -15 V, TA = 125°C) | lGSS | 1 1 | = | - 1.0 - 1.0 | nAdc μAdc |
| Gate Source Cutoff Voltage (VDS = 10 Vdc, ID = 1.0 nAdc) | VGS(off) | -2.0 | _ | -6.5 | Vdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain (VDS = 10 Vdc, VGS = 0) | IDSS | 24 | _ | 60 | mAdc |
| Gate-Source Forward Voltage (IG = 1.0 mAdc, VDS = 0) | V _{GS(f)} | _ | _ | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transfer Admittance (V _{DS} = 10 Vdc, I _D = 10 mAdc, f = 1.0 kHz) | Y _{fs} | 8.0 | _ | 18 | mmhos |
| Output Admittance (V _{DS} = 10 Vdc, I _D = 10 mAdc, f = 1.0 kHz) | lYos | _ | _ | 200 | μmhos |
| Input Capacitance (VGS = -10 Vdc, VDS = 0 Vdc, f = 1.0 MHz) | C _{iss} | _ | _ | 5.0 | pF |
| Reverse Transfer Capacitance (VGS = -10 Vdc, VDS = 0 Vdc, f = 1.0 MHz) | C _{rss} | _ | _ | 2.5 | pF |
| Equivalent Short-Circuit Input Noise Voltage (VDS = 10 Vdc, ID = 10 mAdc, f = 100 Hz) | ēn | - | 10 | _ | nV/√Hz |

MMBFU310

CASE 318-02/03, STYLE 10 SOT-23 (TO-236AA/AB)

FET TRANSISTOR

N-CHANNEL

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|----------------------|--------|-------|------|
| Drain-Source Voltage | VDS | 25 | Vdc |
| Gate-Source Voltage | VGS | 25 | Vdc |
| Gate Current | IG | 10 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | Symbol | Min | Max | Unit |
|--|--------------------|-------|-------|-------|
| OFF CHARACTERISTICS | | | | |
| Gate-Source Breakdown Voltage (I _G = -1.0 μA, V _{DS} = 0) | V(BR)GSS | -25 | - | Vdc |
| Gate 1 Leakage Current (VGS = -15 V, V _{DS} = 0) | l _{G1SS} | - | - 150 | pΑ |
| Gate 2 Leakage Current (VGS = -15 V, VDS = 0, TA = 125°C) | I _{G2SS} | - | - 150 | nA |
| Gate Source Cutoff Voltage (V _{DS} = 10 V, I _D = 1.0 nA) | VGS(off) | - 2.5 | -6.0 | Vdc |
| ON CHARACTERISTICS | | | | |
| Zero-Gate-Voltage Drain (VDS = 10 V, VGS = 0) | IDSS | 24 | 60 | mA |
| Gate-Source Forward Voltage (IG = 10 mA, V _{DS} = 0) | V _{GS(f)} | _ | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Forward Transfer Admittance (VDS = 10 V, ID = 10 mA, f = 1.0 kHz) | Y _{fs} | 10 | 18 | mmhos |
| Output Admittance (VDS = 10 V, lD = 10 mA, f = 1.0 kHz) | lyosł | _ | 150 | μmhos |
| Input Capacitance $(VGS = -10 \text{ V, } VDS = 10 \text{ V, } f = 1.0 \text{ MHz})$ | C _{iss} | _ | 5.0 | pF |
| Reverse Transfer Capacitance (VGS = -10 V, VDS = 10 V, f = 1.0 MHz) | C _{rss} | - | 2.5 | pF |

| Rating | Symbol | Value | Unit |
|--|------------------------------------|------------|-------------|
| Power Dissipation Derate Above 25°C | P _D R _{ØJA} | 350 2.8 | mW mW/°C |
| DC Gate Current | IG | ±20 | mA |
| Repetitive Peak Forward Current 100 μs Pulse Width, 1.0% Duty Cycle 20 μs Pulse Width, 1.0% Duty Cycle | ITRM | 1.0 | Amp |
| Non-Repetitive Peak Forward Current 10 µs Pulse Width | İTSM | 1.0 | Amp |
| Gate to Cathode Forward Voltage | VGKF | 40 | Volt |
| Gate to Cathode Reverse Voltage | VGKR | 5.0 | Volt |
| Gate to Anode Reverse Voltage | VGAR | 40 | Volt |
| Anode to Cathode Voltage | VAK | ±40 | Volt |

MMBPU131

CASE 318-02/03, STYLE 14 SOT-23 (TO-236AA/AB)

UNIJUNCTION TRANSISTOR

THERMAL CHARACTERISTICS

| At | O | 20 | 11-14 |
|---|------------------|------------|-------------|
| Characteristic | Symbol | Max | Unit |
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | RAJA | 357 | •c/w |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | Symbol | Min | Max | Unit |
|---|----------------|-----|------------|-------|
| OFF CHARACTERISTICS | | | | |
| Peak-Point Current (VS = 10 Vdc, RG = 1.0 M Ω) (VS = 10 Vdc, RG = 10 k Ω) | lp | 1 - | 2.0 5.0 | Ац |
| On-State Voltage (V _S = 10 Vdc, R _G = 1.0 MΩ) | VT | 0.2 | 1.6 | Volts |
| Luminous Intensity (Vs = 10 Vdc, Rg = 1.0 M Ω) (Vs = 10 Vdc, Rg = 10 k Ω) | ły | | 50 — | μΑ |
| Anode to Cathode On-State Voltage (IF = 50 mA Peak) | V _F | - | 1.5 | Volts |
| Output Voltage (V _B = 20 Vdc, C _C = 0.2 μF) | Vo | 6.0 | _ | Volts |
| Rise Time $(V_B = 20 \text{ Vdc}, C_C = 0.2 \mu\text{F})$ | tr | _ | 80 | ns |

MMBR901

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

RF AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | V _{CEO} | 15 | Vdc |
| Collector-Base Voltage | VCBO | 25 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | IC | 30 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Comphal | Max | Unit |
|---|------------------|------------|------------|
| Characteristic | Symbol | KRIVI | Unit |
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/℃ |
| Storage Temperature | T _{stg} | 150 | |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | Symbol | Min | Max | Unit |
|---|---------------------|----------|-----------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) | V(BR)CEO | 15 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 0.1 mAdc, I _E = 0) | V(BR)CBO | 25 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 0.1 mAdc, I _C = 0) | V(BR)EBO | 2.0 | - | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) | ІСВО | - | 50 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 5.0 mAdc, VCE = 5.0 Vdc) | hFE | 30 | 200 | ı |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | C _{obo} | _ | 1.0 | pF |
| Common-Emitter Amplifier Power Gain (V _{CC} = 6.0 Vdc, I _C = 5.0 mAdc, f = 1.0 GHz) | G _{pe} (1) | 16 (Typ) | _ | dB |
| Noise Figure (I _C = 5.0 mAdc, V _{CE} = 6.0 Vdc, f = 1.0 GHz) | NF(1) | _ | 1.9 (Typ) | dB |

⁽¹⁾ Noise figure and power gain measured on the Ailtech 7380 50 Ω system.

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 15 | Vdc |
| Collector-Base Voltage | VCBO | 20 | Vdc |
| Emitter-Base Voltage | V _{EBO} | 3.0 | Vdc |
| Collector Current — Continuous | lc | 35 | mAdc |

THERMAL CHARACTERISTICS

| *************************************** | | | |
|---|------------------|------------|-------------|
| Characteristic | Symbol | Max | Unit |
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | .€ |
| *Thermal Resistance Junction to Ambient | RøJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBR920

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

RF AMPLIFIER/SWITCHING TRANSISTOR

NPN SILICON

| ELECTRICAL | CHARACTERISTICS | S (T _A = 25℃ | unless otherwise noted.) |
|------------|-----------------|-------------------------|--------------------------|
| | | | |

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|---------------------|-----|------------|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, Ig = 0) | V(BR)CEO | 15 | _ | | Vdc |
| Collector-Base Breakdown Voltage (I _C = 0.1 mAdc, I _E = 0) | V(BR)CBO | 20 | - | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 0.1 mAdc, I _C = 0) | V(BR)EBO | 2.0 | - | _ | Vdc |
| Collector Cutoff Current (VCB = 10 Vdc, IE = 0) | lCBO | | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 14 mAdc, VCE = 10 Vdc) | hFE | 25 | - | 250 | _ |
| SMALL SIGNAL CHARACTERISTICS | | | | | 1. |
| Current-Gain — Bandwidth Product (IC = 14 mAdc, VCE = 10 Vdc, f = 0.5 GHz) | fT | - | 4.5 | - | GHz |
| Collector-Base Capacitance (VCB = 10 Vdc, Ig = 0, f = 1.0 MHz) | C _{cb} | _ | _ | 1.0 | pF |
| Noise Figure (I _C = 2.0 mAdc, V _{CE} = 10 Vdc, f = 0.5 GHz) (I _C = 2.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 GHz) | NF(1) | = | 2.4 3.0 | _ | dB |
| Common-Emitter Amplifier Power Gain (IC = 2.0 mAdc, VCE = 10 Vdc, f = 0.5 GHz) (IC = 2.0 mAdc, VCE = 10 Vdc, f = 1.0 GHz) | G _{pe} (1) | = | 15 10 | _ | dB |

⁽¹⁾ Noise figure and power gain measured on the Ailtech 7380 50 Ω system.

MMBR930

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

AMPLIFIER/SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| *************************************** | | | |
|---|--------|-------|------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 12 | Vdc |
| Collector-Base Voltage | VCBO | 15 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | lС | 35 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|---------------------|-----|------------|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) | V(BR)CEO | 12 | - | _ | Vđc |
| Collector-Base Breakdown Voltage (IC = 0.1 mAdc, IE = 0) | V(BR)CBO | 15 | _ | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 0.1 mAdc, I _C = 0) | V(BR)EBO | 3.0 | _ | - | Vdc |
| Collector Cutoff Current (VCB = 5.0 Vdc, IE = 0) | ІСВО | _ | - | 50 | nAdc |
| ON CHARACTERISTICS | | | : | | |
| DC Current Gain (IC = 30 mAdc, VCE = 5.0 Vdc) | hFE | 25 | _ | 250 | _ |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Collector-Base Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | C _{cb} | - | _ | 1.0 | pF |
| Noise Figure (I _C = 2.0 mAdc, V _{CE} = 5.0 Vdc, f = 0.5 GHz) (I _C = 2.0 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 GHz) | NF(1) | 11 | 1.9 2.5 | = | dΒ |
| Common-Emitter Amplifier Power Gain (I _C = 2.0 mAdc, V _{CE} = 5.0 Vdc, f = 0.5 GHz) (I _C = 2.0 mAdc, V _{CE} = 5.0 Vdc, f = 0.5 GHz) | G _{pe} (1) | | 11 8.0 | = | dB |

⁽¹⁾ Noise figure and power gain measured on the Ailtech 7380 50 Ω system.

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 5.0 | Vdc |
| Collector-Base Voltage | V _{CBO} | 10 | Vdc |
| Emitter-Base Voltage | VEBO | 2.0 | Vdc |
| Collector Current — Continuous | lc lc | 5.0 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | •℃ |
| *Thermal Resistance Junction to Ambient | RAJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBR931

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

RF AMPLIFIER TRANSISTOR

NPN SILICON

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|-----------------|-----|-----|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 0.1 mAdc, IB = 0) | V(BR)CEO | 5.0 | - | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 0.01 mAdc, I _E = 0) | V(BR)CBO | 10 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 0.1 mAdc, I _C = 0) | V(BR)EBO | 2.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 5.0 Vdc, IE = 0) | СВО | 1 | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 0.25 mAdc, V _{CE} = 1.0 Vdc) | hFE | 30 | _ | 150 | _ |
| SMALL-SIGNAL CHARACTERISTICS | - | | | | |
| Collector-Base Capacitance (VCB = 1.0 Vdc, IE = 0, f = 1.0 MHz) | C _{cb} | - | _ | 0.5 | pF |
| Noise Figure $\{I_E = 0.25 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc}, f = 1.0 \text{ GHz}\}$ | NF(1) | _ | 4.3 | _ | dB |
| Gate Power Dissipation (I _E = 0.25 mAdc, V _{CE} = 1.0 Vdc, f = 1.0 GHz) | PG(1) | _ | 10 | _ | - |

⁽¹⁾ Noise figure and power gain measured on the Ailtech 7380 50 Ω system.

MMBR2060

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

RF AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|--------|-------|------|
| Collector-Emitter Voltage | VCEO | 30 | Vdc |
| Collector-Base Voltage | VCBO | 14 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | lc | 50 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | ROJA | 357 | •c/w |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|-----------|------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) | V(BR)CEO | 14 | _ | Vdc |
| Collector Cutoff Current (VCB = 10 Vdc, IE = 0) | ICBO | - ' | 50 | nAdc |
| Emitter Cutoff Current (VEB = 4.0, IC = 0) | IEBO | _ | 100 | μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 5.0 mAdc, V _{CE} = 5.0 Vdc) (I _C = 20 mAdc, V _{CE} = 10 Vdc, f = 500 MHz) | hFE | 20 2.0 | = | - |
| Collector-Emitter Saturation Voltage (I _C = 80 mAdc, I _B = 8.0 mAdc) | VCE(sat) | _ | 0.38 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 40 mAdc, I _B = 20 mAdc) | V _{BE(sat)} | _ | 0.98 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (I _C = 20 mAdc, V _{CE} = 1.0 Vdc, f = 100 MHz) | f _{T.} | _ | 1.0 | GHz |
| Collector-Base Capacitance (VCB = 10 Vdc, IE = 0) | C _{cb} | _ | 1.0 | pF |
| Emitter-Base Capacitance (VEB = 0.5 Vdc, IC = 0) | C _{eb} | _ | 3.0 | pF |
| Noise Figure (V _{CE} = 10 Vdc, I_E = 1.5 mAdc, f = 450 MHz) | NF(1) | _ | 3.5 | dB |
| Common-Emitter Amplifier Power Gain (VCE = 10 Vdc, I _E = 1.5 mAdc, f = 450 Mhz) | G _{pe} (1) | 12.5 | _ | dB |

⁽¹⁾ Noise figure and power gain measured on the Ailtech 7380 50 Ω system.

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | . 15 | Vdc |
| Collector-Base Voltage | V _{CBO} | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 2.5 | Vdc |
| Collector Current — Continuous | l _C | 40 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit | |
|---|------------------|------------|-------------|--|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C | |
| Storage Temperature | T _{stg} | 150 | °C | |
| *Thermal Resistance Junction to Ambient | RAJA | 357 | °C/W | |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBR2857

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

RF TRANSISTOR

NPN SILICON

| Characteristic | Symbol | Min | Max | Unit |
|---|-----------------|------|------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 3.0 mAdc, IB = 0) | V(BR)CEO | 15 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 1.0 μAdc, I _E = 0) | V(BR)CBO | 30 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 2.5 | _ | Vdc |
| Collector Cutoff Current ($V_{CB} = 15 \text{ Vdc}, I_{E} = 0$) | Ісво | _ | 0.05 | μAdc |
| ON CHARACTERISTICS | · | | | |
| DC Current Gain (IC = 3.0 mAdc, V _{CE} = 1.0 Vdc) | hFE | 30 | - | - |
| SMALL-SIGNAL CHARACTERISTICS | | w | | |
| Current-Gain — Bandwidth Product (IC = 4.0 mAdc, VCE = 10 Vdc, f = 100 MHz) | fτ | 1000 | _ | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, Ig = 0, f = 0.1 MHz) | C _{cb} | | 1.0 | pF |
| Small-Signal Current Gain (IC = 2.0 mAdc, VCE = 6.0 Vdc, f = 1.0 kHz) | hfe | 50 | | _ |
| Noise Figure (IC = 1.5 mAdc, V_{CE} = 6.0 Vdc, R_S = 50 Ω , f = 450 MHz) | NF | _ | 4.5 | dB |
| Common-Emitter Amplifier Power Gain (I _C = 1.5 mAdc, V _{CE} = 6.0 Vdc, f = 450 MHz) | GPE | 12.5 | _ | dΒ |

MMBR4957

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

RF AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | V _{CEO} | 30 | Vdc |
| Collector-Base Voltage | V _{CBO} | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | lc | 30 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | Raja | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | Symbol | Min | Max | Unit |
|--|-----------------|----------|-----------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 30 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 30 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 µAdc, I _C = 0) | V(BR)EBO | 3.0 | _ | Vdc |
| Collector Cutoff Current $(V_{CB} = 10 \text{ Vdc}, _{C} = 0)$ | ІСВО | _ | 0.1 | μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 2.0 mAdc, VCE = 10 Vdc) | hFE | 20 | 150 | _ |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IE = 2.0 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | fT | 1,200 | _ | MHz |
| Collector-Base Capacitance {VCB = 10 Vdc, I _E = 0, f = 1.0 MHz} | C _{cb} | 1 | 0.8 | pF |
| Common-Emitter Amplifier Power Gain(1) (VCE = 10 Vdc, I _C = 2.0 mAdc, f = 450 MHz) | G _{pe} | 17 (Typ) | _ | dB |
| Noise Figure(1) (IC = 2.0 mAdc, VCE = 10 Vdc, f = 450 MHz) | NF | _ | 3.0 (Typ) | ₫B |

⁽¹⁾ Noise figure and power gain measured on the Ailtech 7380 50 Ω system.

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 10 | Vdc |
| Collector-Base Voltage | VCBO | 15 | Vdc |
| Emitter-Base Voltage | V _{EBO} | 3.0 | Vdc |
| Collector Current — Continuous | lc | 20 | mAdc |

THERMAL CHARACTERISTICS

| THE HINTE OFFICE OF LINE 1100 | | | |
|---|------------------|------------|-------------|
| Characteristic | Symbol | Max | Unit |
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBR5031

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

RF AMPLIFIER TRANSISTOR

NPN SILICON

| Characteristic | Symbol | Min | Max | Unit |
|---|---------------------|-------|-----|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) | V(BR)CEO | 10 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.01 mAdc, IE = 0) | V(BR)CBO | 15 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 0.01 mAdc, I _C = 0) | V(BR)EBO | 3.0 | | Vdc |
| Collector Cutoff Current (VCB = 6.0 Vdc, IE = 0) | СВО | - | 10 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 1.0 mAdc, VCE = 6.0 Vdc) | hFE | 25 | 300 | _ |
| SMALL-SIGNAL CHARACTERISTICS | 1 | | | |
| Current-Gain — Bandwidth Product (IC = 5.0 mAdc, VCE = 6.0 Vdc, f = 100 MHz) | fτ | 1,000 | _ | MHz |
| Collector-Base Capacitance (VCE = 6.0 Vdc, I _E = 0, f = 0.1 MHz) | C _{cb} | _ | 1.5 | pF |
| Noise Figure (IC = 1.0 mAdc, VCE = 6.0 Vdc, f = 450 MHz) | NF(1) | _ | 2.5 | dB |
| Common-Emitter Amplifier Power Gain (IC = 1.0 mAdc, VCE = 6.0 Vdc, f = 450 MHz) | G _{pe} (1) | 14 | 25 | dB |

⁽¹⁾ Noise figure and power gain measure on Ailtech 7380 50 Ω system.

MMBR5179

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

RF AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 12 | Vdc |
| Collector-Base Voltage | V _{CBO} | 20 | Vdc |
| Emitter-Base Voltage | VEBO | 2.5 | Vdc |
| Collector Current — Continuous | l _C | 50 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | Tstg | 150 | ဗင |
| *Thermal Resistance Junction to Ambient | Reja | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|-----|------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 3.0 mAdc, Ig = 0) | V(BR)CEO | 12 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.01 mAdc, IE = 0) | V(BR)CBO | 20 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 0.01 mAdc, IC = 0) | V(BR)EBO | 2.5 | _ | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, Ig = 0) | Ісво | _ | 0.02 | μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain {Ic = 3.0 mAdc, Vce = 1.0 Vdc} | hfE | 25 | _ | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | VCE(sat) | _ ` | 0.4 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | V _{BE(sat)} | _ | 1.0 | Vdc |
| SMALL SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 5.0 mAdc, VCE = 6.0 Vdc, f = 100 MHz) | fΤ | 900 | _ | MHz |
| Collector-Base Capacitance (V _{CR} = 10 Vdc, I _E = 0, f = 0.1 to 1.0 MHz) | C _{cb} | 1 | 1.0 | ρF |
| Small Signal Current Gain (IC = 2.0 mAdc, VCE = 6.0 Vdc, f = 1.0 kHz) | h _{fe} | 25 | | _ |
| Noise Figure (I _C = 1.5 mAdc, V _{CE} = 6.0 Vdc, R _S = 50 Ω, f = 200 Mhz) | NF(1) | | 4.5 | dB |
| Common-Emitter Amplifier Power Gain (VCE = 6.0 Vdc, IC = 5.0 mAdc, f = 200 MHz) | G _{pe} (1) | 15 | - | dB |

⁽¹⁾ Noise figure and power gain measured on the Ailtech 7380 50 Ω system.

| Rating | Symbol | Value | Unit |
|---|------------------|-----------------|------|
| Forward Current Avg. (T _C = +67°C) | lF | 510 | mA |
| Peak Forward Gate Voltage | VGFM | 5.0 | V |
| Peak Forward Blocking Voltage; RG = 1.0 k | V _{FXM} | 30 60 100 | V |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | ReJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBS5060,61,62

CASE 318-02/03, STYLE 14 SOT-23 (TO-236AA/AB)

SILICON CONTROLLED RECTIFIER

PNPN DEVICE

| Chara | cteristic | Symbol | Min | Max | Unit |
|---|---|-----------------|-----|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Gate Trigger Voltage (R _L = 100 Ω, R _{GC} = 1.0 kΩ, T _C = 125°C) | Anode Voltage = MMBS5060 = 30 V MMBS5061 = 60 V MMBS5062 = 100 V | VGNT | 0.1 | _ | V |
| Peak Forward Blocking Current (R _{GC} = 1.0 kΩ, T _C = 125°C) | MMBS5060 = 30 V V _{FXM} = MMBS5061 = 60 V MMBS5062 = 100 V | IFXM | - | 50 | μА |
| Peak Reverse Blocking Current $(R_{GC} = 1.0 \text{ k}\Omega,$ $T_{C} = 125^{\circ}\text{C})$ | V _{RXM} = MMBS5060 = 30 V MMBS5061 = 60 V MMBS5062 = 100 V | IRXM | - | 50 | μΑ |
| Forward Voltage* (IF = 1.2 A Peak) | | VF | - | 1.7 | ٧ |
| Gate Trigger Current** (RGC = 1.0 kΩ, V _{AC} = 7.0 V, R _L = 100 | ο Ω | ^I GT | _ | 200 | μΑ |
| Gate Trigger Voltage (RGC = 1.0 kΩ, VAC = 7.0 V, R _L = 100 |) n | V _{GT} | _ | 0.8 | ٧ |
| Holding Current (VAC = 7.0 V, RGC = 1.0 k Ω | | lн | _ | 5.0 | mA |

^{*}PW ≤ 1.0 ms, D.C. ≤ 1.0%.

^{**}RGC current not included in measurement.

MMBT404,A

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

CHOPPER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| | | Va | | |
|--------------------------------|------------------|-----|------|------|
| Rating | Symbol | 404 | 404A | Unit |
| Collector-Emitter Voltage | VCEO | 24 | 35 | Vdc |
| Collector-Base Voltage | V _{CBO} | 25 | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 12 | 25 | Vdc |
| Collector Current — Continuous | ¹c | 1 | 50 | mAdc |

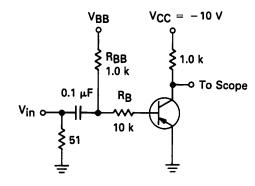
THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | RøJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|---------------------|------------------|----------|----------|--------------|----------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, I _B = 0) | MMBT404 MMBT404A | V(BR)CEO | 24 35 | - | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 μ Adc, IE = 0) | MMBT404 MMBT404A | V(BR)CBO | 25 40 | - | 1-1 | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | MMBT404 MMBT404A | V(BR)EBO | 12 25 | | 1.1 | Vdc |
| Collector Cutoff Current (VCB = 10 Vdc, I _E = 0) | | lСВО | | _ | 100 | nAdc |
| Emitter Cutoff Current (VBE = 10 Vdc, IC = 0) | | !EBO | _ | _ | 100 | nAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain (IC = 12 mAdc, VCE = 0.15 Vdc) | | hFE | 30 | _ | 400 | <u> </u> |
| Collector-Emitter Saturation Voltage (I _C = 12 mAdc, I _B = 0.4 mAdc) (I _C = 24 mAdc, I _B = 1.0 mAdc) | | VCE(sat) | 11 | _ | 0.15 0.20 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 12 mAdc, I _B = 0.4 mAdc) (I _C = 24 mAdc, I _B = 1.0 mAdc) | | VBE(sat) | - | <u>-</u> | 0.85 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Output Capacitance (VCB = 6.0 Vdc, IE = 0) | | C _{obo} | _ | | 20 | ρF |
| SWITCHING CHARACTERISTICS | | | | | | |
| Delay Time (VCC = 10 Vdc, IC = 10 mAdc) (Figure 1) | | t _d | _ | 43 | | ns |
| Rise Time (lg ₁ = 1.0 mAdc, V _{BE} (off) = 14 Vdc) | | t _r | _ | 180 | | ns |
| Storage Time (V _{CC} = 10 Vdc, I _C = 10 mAdc) | | t _S | | 675 | _ | ns |
| Fall Time (I _{B1} = I _{B2} = 1.0 mAdc) (Figure 1) | | tf | _ | 160 | | ns |

FIGURE 1 — SWITCHING TIME TEST CIRCUIT



| | V _{in} (Volts) | V _{BB} (Volts) |
|-----------------|----------------------------|----------------------------|
| ton, td, tr | - 12 | +1.4 |
| toff, ts and tf | + 20.6 | - 11.6 |

Voltages and resistor values shown are for $I_C = 10$ mA, $I_C/I_B = 10$ and $I_{B1} = I_{B2}$

MMBT918

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

VHF/UHF TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 15 | Vdc |
| Collector-Base Voltage | V _{CBO} | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | lc lc | 350 | mAdc |

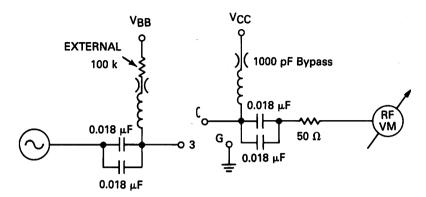
THERMAL CHARACTERISTICS

| *************************************** | | | |
|---|------------------|------------|-------------|
| Characteristic | Symbol | Max | Unit |
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | •€ |
| *Thermal Resistance Junction to Ambient | ReJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | Symbol | Min | Max | Unit |
|---|-----------------------|-----|------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 3.0 mAdc, I _B = 0) | V(BR)CEO | 15 | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 1.0 µAdc, I _E = 0) | V _(BR) CBO | 30 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | V(BR)EBO | 3.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) | Ісво | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 3.0 mAdc, VCE = 1.0 Vdc) | hFE | 20 | _ | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | VCE(sat) | ı | 0.4 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | V _{BE(sat)} | - | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 4.0 mAdc, VCE = 10 Vdc, f = 100 MHz) | fτ | 600 | _ | MHz |
| Output Capacitance (V _{CB} = 0 Vdc, I _E = 0, f = 1.0 MHz) (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | _ | 3.0 1.7 | pF |
| Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | C _{ibo} | _ | 2.0 | pF |
| Noise Figure (I _C = 1.0 mAdc, V_{CE} = 6.0 Vdc, R _S = 50 Ω , f = 60 MHz) (Figure 1) | NF | - | 6.0 | dB |
| Power Output (IC = 8.0 mAdc, VCB = 15 Vdc, f = 500 MHz) | P _{out} | 30 | _ | mW |
| Common-Emitter Amplifier Power Gain (IC = 6.0 mAdc, VCB = 12 Vdc, f = 200 MHz) | G _{pe} | 11 | _ | dB |

FIGURE 1 — NF, Gpe MEASUREMENT CIRCUIT 20-200



NF Test Conditions

 $I_C = 1.0 \text{ Amp}$

VCE = 6.0 Volts

 $R_S = 50 \Omega$ f = 60 MHz

Gpe Test Conditions

 $I_C = 6.0 \text{ mA}$

V_{CE} = 12 Volts f = 200 MHz

MMBT930

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 45 | Vdc |
| Collector-Base Voltage | V _{CBO} | 45 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 30 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

Refer to MPS3904 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|------------------|------------|-----|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 10 mAdc, I _B = 0) | V(BR)CEO | 45 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 45 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 5.0 | | Vdc |
| Collector Cutoff Current (VCE = 5.0 Vdc, I _B = 0) | ICEO | _ | 10 | nAdc |
| Collector Cutoff Current (V _{CB} = 45 Vdc, I _E = 0) | 1СВО | _ | 10 | nAdc |
| Collector Cutoff Current (V _{CE} = 45 Vdc, V _{BE} = 0) | ICES | _ | 10 | nAdc |
| Emitter Cutoff Current (VEB = 5.0 Vdc, I _C = 0) | IEBO | _ | 10 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gein (I _C = 10 μ Adc, V _{CE} = 5.0 Vdc) (I _C = 500 μ Adc, V _{CE} = 5.0 Vdc) (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) | ptE | 100 150 | 300 | - |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 0.5 mAdc) | VCE(sat) | _ | 1.0 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, I _B = 0.5 mAdc) | VBE(sat) | 0.6 | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 500 µAdc, VCE = 5.0 Vdc, f = 30 MHz) | fτ | 30 | _ | MHz |
| Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | _ | 8.0 | pF |
| Noise Figure (I _C = 10 μ Adc, V _{CE} = 5.0 Vdc, R _S = 10 k Ω , f = 10 Hz to 15.7 kHz) | NF | _ | 3.0 | dB |

| Rating | Symbol | MMBT2222 | MMBT2222A | Unit |
|--------------------------------|------------------|----------|-----------|------|
| Collector-Emitter Voltage | VCEO | 30 | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 60 | 75 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | 6.0 | Vdc |
| Collector Current — Continuous | lc | (| 300 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBT2222,A

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

TRANSISTOR

NPN SILICON

Refer to MPS2222 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|--|----------|---|--------------------------|------|
| OFF CHARACTERISTICS | - | | | | |
| Collector-Emitter Breakdown Voltage | MMBT2222 MMBT2222A | V(BR)CEO | 30 40 | = | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | MMBT2222 MMBT2222A | V(BR)CBO | 60 75 | = | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 μAdc, IC = 0) | MMBT2222 MMBT2222A | V(BR)EBO | 5.0 6.0 | = | Vdc |
| Collector Cutoff Current (VCE = 60 Vdc, VEB(off) = 3.0 Vdc) | MMBT2222A | CEX | _ | 10 | nAdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) (VCB = 60 Vdc, IE = 0) (VCB = 50 Vdc, IE = 0, TA = 125°C) (VCB = 50 Vdc, IE = 0, TA = 125°C) | MMBT2222 MMBT2222A MMBT2222 MMBT2222A | ІСВО | | 0.01 0.01 10 10 | μAdc |
| Emitter Cutoff Current (VEB = 3.0 Vdc, IC = 0) | MMBT2222A | ¹EBO | _ | 10 | nAdc |
| Base Cutoff Current (VCE = 60 Vdc, VEB(off) = 3.0 Vdc) | MMBT2222A | lBL l | - | 20 | nAdc |
| ON CHARACTERISTICS DC Current Gain (IC = 0.1 mAdc, VCE = 10 Vdc) (IC = 1.0 mAdc, VCE = 10 Vdc) (IC = 10 mAdc, VCE = 10 Vdc) (IC = 10 mAdc, VCE = 10 Vdc, TA = -55°C) (IC = 150 mAdc, VCE = 10 Vdc)(1) (IC = 150 mAdc, VCE = 1.0 Vdc)(1) (IC = 500 mAdc, VCE = 10 Vdc)(1) | MMBT2222A only MMBT2222 MMBT2222A | hFE | 35 50 75 35 100 50 30 40 | 300 | _ |
| Collector-Emitter Saturation Voltage(1) (IC = 150 mAdc, I _B = 15 mAdc) | MMBT2222 MMBT2222A | VCE(sat) | = | 0.4 0.3 | Vdc |
| (I _C = 500 mAdc, I _B = 50 mAdc) | MMBT2222 MMBT2222A | | Ξ | 1.6 1.0 | |

| Characteristic | | Symbol | Min | Max | Unit |
|--|------------------------|-------------------|-------------|-------------|--------|
| Base-Emitter Saturation Voltage(1) (I _C = 150 mAdc, I _B = 15 mAdc) | MMBT2222 MMBT2222A | VBE(sat) | — 0.6 | 1.3 1.2 | Vdc |
| (IC = 500 mAdc, tg = 50 mAdc) | MMBT2222 MMBT2222A | | _ | 2.6 2.0 | |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product(2) (IC = 20 mAdc, VCE = 20 Vdc, f = 100 MHz) | MMBT2222 MMBT2222A | fτ | 250 300 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | | Cobo | _ | 8.0 | pF |
| Input Capacitance (VEB = 0.5 Vdc, $I_C = 0$, $f = 1.0$ MHz) | MMBT2222 MMBT2222A | Cibo | _ | 30 25 | pF |
| Input Impedance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | MMBT2222A MMBT2222A | h _{ie} | 2.0 0.25 | 8.0 1.25 | kΩ |
| Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | MMBT2222A MMBT2222A | h _{re} | | 8.0 4.0 | X 10-4 |
| Small-Signal Current Gain ($I_C = 1.0 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$) ($I_C = 10 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$) | MMBT2222A MMBT2222A | h _{fe} | 50 75 | 300 375 | _ |
| Output Admittance (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) (IC = 10 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | MMBT2222A MMBT2222A | h _{oe} | 5.0 25 | 35 200 | μmhos |
| Collector Base Time Constant (I _E = 20 mAdc, V _{CB} = 20 Vdc, f = 31.8 MHz) | MMBT2222A | rb'C _C | _ | 150 | ps |
| Noise Figure (IC = 100 μ Adc, VCE = 10 Vdc, RS = 1.0 k Ω , f = 1.0 kHz) | MMBT2222A | NF | 4.0 | 4.0 | dB |
| SWITCHING CHARACTERISTICS MMBT2222A only | | | | | |
| Delay Time (VCC = 30 Vdc, VBE(off) = 0.5 Vd | tc, | ^t d | _ | 10 | ns |
| Rise Time IC = 150 mAdc, IB1 = 15 mAdc) | | t _r | | 25 | ns |
| Storage Time (VCC = 30 Vdc, IC = 150 mAdc, | | ts | | 225 | ns |
| Fall Time IB1 = IB2 = 15 mAdc) | | tf | | 60 | ns |

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

⁽²⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 15 | Vdc |
| Collector-Emitter Voltage | VCES | 40 | Vdc |
| Collector-Base Voltage | VCBO | 40 | Vdc |
| Emitter-Base Voltage | V _{EBO} | 4.5 | Vdc |
| Collector Current — Continuous | lc | 500 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | Tstg | 150 | ဇ |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBT2369

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB) SWITCHING TRANSISTOR

NPN SILICON

Refer to MPS2369 for graphs.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------------------|----------------|-----|-------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | V(BR)CEO | 15 | _ | _ | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 10 µAdc, VBE = 0) | V _{(BR)CES} | 40 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 40 | _ | _ | Vdc |
| (lg = 10 µAdc, lC = 0) | V(BR)EBO | 4.5 | _ | - | Vdc |
| Collector Cutoff Current (VCB = 20 Vdc, IE = 0) (VCB = 20 Vdc, IE = 0, TA = 125°C) | Ісво | | = | 0.4 30 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(1) (Ic = 10 mAdc, VcE = 1.0 Vdc) (Ic = 10 mAdc, VcE = 1.0 Vdc, TA = -55°C) (Ic = 100 mAdc, VcE = 2.0 Vdc) | hFE | 40 20 20 | = | 120 | _ |
| Collector-Emitter Saturation Voltage(1) (IC = 10 mAdc, Ig = 1.0 mAdc) | V _{CE(sat)} | | _ | 0.25 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 10 mAdc, IB = 1.0 mAdc) | V _{BE(sat)} | 0.70 | - | 0.85 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Output Capacitance (VCB = 5.0 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | _ | | 4.0 | pF |
| Small Signal Current Gain (IC = 10 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | h _{fe} | 5.0 | _ | _ | - |
| SWITCHING CHARACTERISTICS | | | | | |
| Storage Time $(I_{B1} = I_{B2} = I_{C} = 10 \text{ mAdc})$ | ts | - | 5.0 | 13 | ns |
| Turn-On Time (V _{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = 3.0 mAdc) | ton | | 8.0 | 12 | ns |
| Turn-Off Time ($V_{CC} = 3.0 \text{ Vdc}$, $I_{C} = 10 \text{ mAdc}$, $I_{B1} = 3.0 \text{ mAdc}$, $I_{B2} = 1.5 \text{ mAdc}$) | ^t off | _ | 10 | 18 | ns |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MMBT2484

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

LOW NOISE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 60 | Vdc |
| Collector-Base Voltage | V _{CBO} | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | Vdc |
| Collector Current — Continuous | lc | 50 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | Reja | 357 | °C⁄W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

Refer to MPSA18 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|---------|----------|--------------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, I _B = 0) | V(BR)CEO | 60 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 μ Adc, IE = 0) | V(BR)CBO | 60 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 45 Vdc, IE = 0) (VCB = 45 Vdc, IE = 0, TA 150°C) | Ісво | = | 10 10 | nAdc µAdc |
| Emitter Cutoff Current (VBE = 5.0 Vdc, IC = 0) | IEBO | _ | 10 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc) (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) | hFE | 250 | 800 | - |
| Collector-Emitter Saturation Voltage (IC = 1.0 mAdc, IB = 0.1 mAdc) | V _{CE(sat)} | - | 0.35 | Vdc |
| Base-Emitter On Voltage (IC = 1.0 mAdc, VCE = 5.0 Vdc) | V _{BE(on)} | _ | 0.95 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Output Capacitance (VCB = 5.0 Vdc, I_E = 0, f = 140 kHz) | C _{obo} | _ | 6.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I_C = 0, f = 140 kHz) | C _{ibo} | _ | 6.0 | pF |
| Noise Figure (I _C = 10 μ Adc, V _{CE} = 5.0 Vdc, R _S = 10 kΩ, f = 1.0 kHz, BW = 200 Hz) | NF | _ | 3.0 | ďΒ |

| Rating | Symbol | MPS2907 | MPS2907A | Unit |
|--------------------------------|--------|---------|----------|------|
| Collector-Emitter Voltage | VCEO | 40 | 60 | Vdc |
| Collector-Base Voltage | VCBO | | 60 | Vdc |
| Emitter-Base Voltage | VEBO | | 5.0 | Vdc |
| Collector Current — Continuous | lc | [(| 600 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | Reja | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBT2907,A

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

Refer to MPS2907 for graphs.

| Characteris | stic | Symbol | Min | Max | Unit |
|---|-----------------------|----------------------|-----------|----------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | MMBT2907 MMBT2907A | V(BR)CEO | 40 60 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | | V(BR)CBO | 60 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 30 Vdc, VBE(off) = 0.5 Vdc) | | ICEX | _ | 50 | nAdc |
| Collector Cutoff Current (VCB = 50 Vdc, I _E = 0) | MMBT2907 MMBT2907A | СВО | _ | 0.020 0.010 | μAdc |
| $(V_{CB} = 50 \text{ Vdc}, I_{E} = 0, T_{A} = 125^{\circ}C)$ | MMBT2907 MMBT2907A | | 1 1 | 20 10 | |
| Base Current (VCE = 30 Vdc, VBE(off) = 0.5 Vdc) | | IB | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 0.1 mAdc, V _{CE} = 10 Vdc) | MMBT2907 MMBT2907A | pŁE | 35 75 | = | _ |
| $(I_C = 1.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})$ | MMBT2907 MMBT2907A | | 50 100 | = | |
| (IC = 10 mAdc, V_{CE} = 10 Vdc) | MMBT2907 MMBT2907A | | 75 100 | = | |
| $(I_C = 150 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})(1)$ | MMBT2907, MMBT2907A | | 100 | 300 | |
| $(I_C = 500 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})(1)$ | MMBT2907 MMBT2907A | | 30 50 | _ | |
| Collector-Emitter Saturation Voltage(1) (I _C = 150 mAdc, I _B = 15 mAdc) (I _C = 500 mAdc, I _B = 50 mAdc) | | VCE(sat) | _ | 0.4 1.6 | Vdc |
| Base-Emitter Saturation Voltage(1) (I _C = 150 mAdc, I _B = 15 mAdc) (I _C = 500 mAdc, I _B = 50 mAdc) | | V _{BE(sat)} | _ | 1.3 2.6 | Vdc |

| | Characteristic | Symbol | Min | Max | Unit |
|---|--|------------------|-----|-----|---------|
| SMALL-SIGNAL CHARA | CTERISTICS | | | | |
| Current-Gain — Bandwid | th Product(1),(2) 20 Vdc, f = 100 MHz) | fτ | 200 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0 | , f = 1.0 MHz) | Cobo | _ | 8.0 | pF |
| Input Capacitance (VBE = 2.0 Vdc, IC = 0 | 0, f = 1.0 MHz) | C _{ibo} | _ | 30 | pF |
| SWITCHING CHARACTE | RISTICS | | - | · | |
| Turn-On Time | | ton | _ | 45 | ns |
| Delay Time | (VCC = 30 Vdc, IC = 150 mAdc, IB1 = 15 mAdc) | t _d | | 10 | ns |
| Rise Time | | tr | _ | 40 | ns |
| Turn-Off Time | | toff | _ | 100 | ns |
| Storage Time | (VCC = 6.0 Vdc, IC = 150 mAdc, IR1 = IR2 = 15 mAdc) | t _s | | 80 | ns |
| Fall Time | IBI IBZ IO III/GO) | tf | | 30 | ns |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

⁽²⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.

| Rating | Symbol | Value | Unit |
|--------------------------------|--------|-------|------|
| Collector-Emitter Voltage | VCEO | 12 | Vdc |
| Collector-Base Voltage | VCBO | 12 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | Ic | 80 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | RAJA | 357 | •c/w |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBT3640

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

SWITCHING TRANSISTOR

PNP SILICON

Refer to MPS3640 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| THE STATE OF THE S | Characteristic | Symbol | Min | Max | Unit |
|--|---|----------------------|------------------|--------------------|------|
| OFF CHARACTERISTICS | 4.10.101010 | | | | |
| | Itage (I _C = 100 μAdc, V _{BE} = 0) | V(BR)CES | 12 | _ | Vdc |
| | tage(1) (IC = 10 mAdc, IB = 0) | VCEO(sus) | 12 | | Vdc |
| Collector-Base Breakdown Volta | | V(BR)CBO | 12 | | Vdc |
| Emitter-Base Breakdown Voltage | | V(BR)EBO | 4.0 | | Vdc |
| Collector Cutoff Current (VCE | | CES | = | 0.01 1.0 | μAdc |
| Base Current (VCE = 6.0 Vdc, | V _{BE} = 0) | lg | _ | 10 | nAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain (I _C = 10 mAc (I _C = 50 mAc | tc, V _{CE} = 0.3 Vdc) tc, V _{CE} = 1.0 Vdc) | pŁE | 30 20 | 120 — | _ |
| Collector-Emitter Saturation Vol | tage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc) (I _C = 10 mAdc, I _B = 1.0 mAdc, T _A = 65°C) | VCE(sat) | = | 0.2 0.6 0.25 | Vdc |
| Base-Emitter Saturation Voltage | (IC = 10 mAdc, IB = 0.5 mAdc) (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc) | V _{BE(sat)} | 0.75 0.8 — | 0.95 1.0 1.5 | Vdc |
| SMALL SIGNAL CHARACTERIS | TICS | | | | |
| Current-Gain — Bandwidth Proc | duct (IC = 10 mAdc, VCE = 5.0 Vdc, f = 100 MHz) | fτ | 500 | - | MHz |
| Output Capacitance (VCB = = | 5.0 Vdc, IE = 0, f = 1.0 MHz) | Cobo | _ | 3.5 | pF |
| Input Capacitance (VBE = 0.5 | Vdc, IC = 0, f = 1.0 MHz) | Cibo | _ | 3.5 | pF |
| SWITCHING CHARACTERISTICS | S | | | | |
| Delay Time (V _{CC} | = 6.0 Vdc, IC = 50 mAdc, VBE(off) = 1.9 Vdc, | t _d | _ | 10 | ns |
| Rise Time IB1 | = 5.0 mAdc) | t _r | _ | 30 | ns |
| Storage Time (VCC | c = 6.0 Vdc, IC = 50 mAdc, IB1 = IB2 = 5.0 mAdc) | t _s | | 20 | ns |
| Fall Time | | tf | _ | 12 | ns |
| Turn-On Time (V _{CC} = 6.0 Vdc, I _C = 50 mAc (V _{CC} = 1.5 Vdc, I _C = 10 mAc | tc, VBE(off) = 1.9 Vdc, IB1 = 5.0 mAdc) tc, IB1 = 0.5 mAdc) | ton | _ | 25 60 | ns |
| Turn-Off Time | dc, VBE(off) = 1.9 V, IB1 = IB2 = 5.0 mAdc) | toff | 1 - | 35 75 | ns |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MMBT3903 MMBT3904

CASE 318-03, STYLE 6 SOT-23 (TO-236AA/AB)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | V _{CEO} | 40 | Vdc |
| Collector-Base Voltge | V _{CBO} | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | Vdc |
| Collector Current — Continuous | l _C | 200 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | Raja | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

Refer to 2N3903 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|----------------------|----------------------|------------|--------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, Ig = 0) | | V(BR)CEO | 40 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | | V(BR)CBO | 60 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | | V(BR)EBO | 6.0 | _ | Vdc |
| Base Cutoff Current (VCE = 30 Vdc, VEB = 3.0 Vdc) | | [‡] BL | _ | 50 | nAdc |
| Collector Cutoff Current (VCE = 30 Vdc, VEB = 3.0 Vdc) | | ICEX | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(1) (I _C = 0.1 mAdc, V _{CE} = 1.0 Vdc) | MMBT3903 MMBT3904 | pŁE | 20 40 | _ | _ |
| (IC = 1.0 mAdc, V _{CE} = 1.0 Vdc) | MMBT3903 MMBT3904 | | 35 70 | = | |
| (IC = 10 mAdc, $V_{CE} = 1.0 \text{ Vdc}$) | MMBT3903 MMBT3904 | | 50 100 | 150 300 | |
| $(I_C = 50 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc})$ | MMBT3903 MMBT3904 | | 30 60 | _ | |
| (IC = 100 mAdc, V_{CE} = 1.0 Vdc) | MMBT3903 MMBT3904 | | 15 30 | _ | , |
| Collector-Emitter Saturation Voltage(1) (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc) | | VCE(sat) | = | 0.2 0.3 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc) | | V _{BE(sat)} | 0.65 | 0.85 0.95 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 100 MHz) | MMBT3903 MMBT3904 | fΤ | 250 300 | _ | MHz |

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

| | Characteristic | | Symbol | Min | Max | Unit |
|--|---|----------------------|------------------|------------|------------|----------|
| Output Capacitance (VCB = 5.0 Vdc, IE | = 0, f = 1.0 MHz) | | C _{obo} | _ | 4.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC | = 0, f = 1.0 MHz) | | Cibo | _ | 8.0 | pF |
| (IC = 1.0 mAdc, Vo | CE = 10 Vdc, f = 1.0 kHz) | MMBT3903 MMBT3904 | hie | 1.0 1.0 | 8.0 10 | k ohms |
| Voltage Feedback Rat (IC = 1.0 mAdc, Vo | tio E = 10 Vdc, f = 1.0 kHz) | MMBT3903 MMBT3904 | h _{re} | 0.1 0.5 | 5.0 8.0 | X 10-4 |
| Small-Signal Current (IC = 1.0 mAdc, Vo | Gain E = 10 Vdc, f = 1.0 kHz) | MMBT3903 MMBT3904 | hfe | 50 100 | 200 400 | _ |
| Output Admittance | ce = 10 Vdc, f = 1.0 kHz) | | h _{oe} | 1.0 | 40 | μmhos |
| f = 10 Hz to 15.7 k | | MMBT3903 MMBT3904 | NF | _ | 6.0 5.0 | dB |
| SWITCHING CHARA | | | - | | | T |
| Delay Time Rise Time | (V _{CC} = 3.0 Vdc, V _{BE} = 0.5 Vdc, I _C = 10 mAdc, I _{B1} = 1.0 mAdc) | | t _d | | 35 35 | ns ns |
| Storage Time | (V _{CC} = 3.0 Vdc, l _C = 10 mAdc, l _{B1} = l _{B2} = 1.0 mAdc) | MMBT3903 MMBT3904 | ts | 1 - | 175 200 | ns |
| Fall Time | | | • | | 50 | |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MMBT3906

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | l _C | 200 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

Refer to 2N3905 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|-----------------------|-----------------------------|-----------------|--------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 40 | - | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 µAdc, I _E = 0) | V(BR)CBO | 40 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | Vdc |
| Base Cutoff Current (VCE = 30 Vdc, VBE = 3.0 Vdc) | IBL | | 50 | nAdc |
| Collector Cutoff Current (VCE = 30 Vdc, VBE = 3.0 Vdc) | ICEX | - | 50 | nAdc |
| ON CHARACTERISTICS(1) | | | | |
| DC Current Gain (I _C = 0.1 mAdc, V _{CE} = 1.0 Vdc) (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) (I _C = 50 mAdc, V _{CE} = 1.0 Vdc) (I _C = 100 mAdc, V _{CE} = 1.0 Vdc) | hFE | 60 80 100 60 30 | 300 | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc) | VCE(sat) | = | 0.25 0.4 | Vdc |
| Base-Emitter Saturation Voltage {I _C = 10 mAdc, I _B = 1.0 mAdc} (I _C = 50 mAdc, I _B = 5.0 mAdc) | V _{BE} (sat) | 0.65 | 0.85 0.95 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | Т- | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz) | fτ | 250 | _ | MHz |
| Output Capacitance (VCB = 5.0 Vdc, IE = 0, f = 100 kHz) | C _{obo} | _ | 4.5 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 100 kHz) | C _{ibo} | | 10.0 | pF |
| Input Impedance (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{ie} | 2.0 | 12 | k ohms |
| Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{re} | 0.1 | 10 | X 10-4 |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{fe} | 100 | 400 | |

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|--|-----------------|-----|-----|-------|
| Output Admittance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{oe} | 3.0 | 60 | μmhos |
| Noise Figure (IC = 100 μ Adc, VCE = 5.0 Vdc, RS = 1.0 k ohm, f = 10 10 Hz to 15.7 kHz) | NF | _ | 4.0 | dB |

SWITCHING CHARACTERISTICS

| Delay Time | (VCC = 3.0 Vdc, VBE = 0.5 Vdc | td | _ | 35 | ns |
|--------------|---|----------------|---|-----|----|
| Rise Time | IC = 10 mAdc, IB1 = 1.0 mAdc) | t _F | | 35 | ns |
| Storage Time | (VCC = 3.0 Vdc, IC = 10 mAdc, | ts | _ | 225 | ns |
| Fail Time | I _{B1} = I _{B2} = 1.0 mAdc) | tf | _ | 75 | ns |

⁽¹⁾ Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MMBT4124

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | 2N4124 | Unit |
|--------------------------------|------------------|--------|------|
| Collector-Emitter Voltage | VCEO | 25 | Vdc |
| Collector-Base Voltage | V _{CBO} | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 200 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

Refer to 2N4123 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|------------|---------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IE = 0) | V(BR)CEO | 25 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 30 | _ | Vdc |
| Emitter-Base Breakdown Voltage (lg = 10 μAdc, lC = 0) | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 20 Vdc, I _E = 0) | ICBO | - | 50 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, I _C = 0) | IEBO | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain(1) (Ic = 2.0 mAdc, V _{CE} = 1.0 Vdc) (Ic = 50 mAdc, V _{CE} = 1.0 Vdc) | ptE | 120 60 | 360 | - |
| Collector-Emitter Saturation Voltage(1) (IC = 50 mAdc, Ig = 5.0 mAdc) | VCE(sat) | - | 0.3 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 50 mAdc, IB = 5.0 mAdc) | V _{BE(sat)} | _ | 0.95 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, V _{CE} = 20 Vdc, f = 100 MHz) | fT | 300 | _ | MHz |
| Output Capacitance (VCB = 5.0 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | _ | 4.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 100 kHz) | C _{ibo} | _ | 8.0 | pF |
| Collector-Base Capacitance (IE = 0, VCB = 5.0 V, f = 100 kHz) | C _{cb} | _ | 4.0 | pF |
| Small-Signal Current Gain (IC = 2.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{fe} | 120 | 480 | _ |
| Current Gain — High Frequency (IC = 10 mAdc, V _{CE} = 20 Vdc, f = 100 MHz) (IC = 2.0 mAdc, V _{CE} = 10 V, f = 1.0 kHz) | lhfel | 3.0 120 | 480 | _ |
| Noise Figure (IC = 100 µAdc, VCE = 5.0 Vdc, RS = 1.0 kohm, Noise Bandwidth = 10 Hz to 15.7 kHz) | NF | _ | 5.0 | dB |

(1) Pulse Test: Pulse Width = 300 μ s, Duty Cycle = 2.0%.

| Rating | Symbol | 2N4125 | 2N4126 | Unit | | |
|---|-----------------------------------|------------|-------------|---------------|--|------|
| Collector-Emitter Voltage | VCEO | 30 | 25 | Vdc | | |
| Collector-Base Voltage | VCBO | 30 | 25 | Vdc | | |
| Emitter-Base Voltage | VEBO | 3 4.0 | | Vdc | | |
| Collector Current — Continuous | lc | 200 | | 200 | | mAdc |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 350 2.8 | | mW mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 8.0 | | Watt mW/°C | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 55 te | -55 to +150 | | | |

THERMAL CHARACTERISTICS

| TILLIMAL GIAIDO LINGTIGO | | | |
|---|-------------------|------------|-------------|
| Characteristic | Symbol | Max | Unit |
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _Ø JA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBT4125

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

Refer to 2N4125 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|----------|----------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IE = 0) | V(BR)CEO | 30 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 30 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 4.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 20 Vdc, IE = 0) | ICBO | _ | 50 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | IEBO | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain(1) (I _C = 2.0 mAdc, V _{CE} = 1.0 Vdc) (I _C = 50 mAdc, V _{CE} = 1.0 Vdc) | hFE | 50 25 | 150 — | |
| Collector-Emitter Saturation Voltage(1) (IC = 50 mAdc, Ig = 5.0 mAdc) | VCE(sat) | | 0.4 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 50 mAdc, IB = 5.0 mAdc) | V _{BE(sat)} | _ | 0.95 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz) | fτ | 200 | _ | MHz |
| Input Capacitance $V_{BE} = 0.5 \text{ Vdc}$, $I_{C} = 0$, $f = 100 \text{ kHz}$ | C _{ibo} | ı | 10 | pF |
| Collector-Base Capacitance {VCB = 5.0 Vdc, IE = 0, f = 100 kHz} | C _{cb} | - | 4.5 | ρF |
| Smail-Signal Current Gain (I _C = 2.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{fe} | 50 | 200 | _ |
| Current Gain — High Frequency (IC = 10 mAdc, V _{CE} = 20 Vdc, f = 100 MHz) | h _{fe} | 2.0 | _ | _ |
| Noise Figure (I _C = 100 μ Adc, V _{CE} = 5.0 Vdc, R _S = 1.0 kohm, Noise Bandwidth = 10 Hz to 15.7 kHz) | NF | _ | 5.0 | dB |

⁽¹⁾ Pulse Test: Pulse Width = 300 μ sec, Duty Cycle = 2.0%.

MMBT4401

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | Vdc |
| Collector Current — Continuous | lc | 600 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | Tstg | 150 | °C |
| *Thermal Resistance Junction to Ambient | ReJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

Refer to 2N4401 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|-----------------------------|-------------|----------|
| OFF CHARACTERISTICS | | | 1 | <u> </u> |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 40 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 0.1 mAdc, I _E = 0) | V(BR)CBO | 60 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 0.1 mAdc, IC = 0) | V(BR)EBO | 6.0 | _ | Vdc |
| Base Cutoff Current (VCE = 35 Vdc, VEB = 0.4 Vdc) | IBEV | _ | 0.1 | μAdc |
| Collector Cutoff Current (V _{CE} = 35 Vdc, V _{EB} = 0.4 Vdc) | ICEX | _ | 0.1 | μAdc |
| ON CHARACTERISTICS(1) | | | | |
| DC Current Gain ($I_C = 0.1 \text{ mAdc}$, $V_{CE} = 1.0 \text{ Vdc}$) ($I_C = 1.0 \text{ mAdc}$, $V_{CE} = 1.0 \text{ Vdc}$) ($I_C = 10 \text{ mAdc}$, $V_{CE} = 1.0 \text{ Vdc}$) ($I_C = 150 \text{ mAdc}$, $V_{CE} = 1.0 \text{ Vdc}$) ($I_C = 100 \text{ mAdc}$, $I_C = 100 \text{ Vdc}$) ($I_C = 100 \text{ mAdc}$) | hFE | 20 40 80 100 40 | 300 | - |
| Collector-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) (IC = 500 mAdc, IB = 50 mAdc) | V _{CE(sat)} | = | 0.4 0.75 | Vdc |
| Base-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) (IC = 500 mAdc, IB = 50 mAdc) | V _{BE(sat)} | 0.75 | 0.95 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 20 mAdc, VCE = 10 Vdc, f = 100 MHz) | fT | 250 | - | MHz |
| Collector-Base Capacitance (VCB = 5.0 Vdc, !g = 0, f = 100 kHz) | C _{cb} | _ | 6.5 | pF |
| Emitter-Base Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 100 kHz) | C _{eb} | _ | 30 | pF |
| Input Impedance (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{ie} | 1.0 | 15 | k ohms |
| Voltage Feedback Ratio (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{re} | 0.1 | 8.0 | X 10-4 |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{fe} | 40 | 500 | - |
| Output Admittance (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{oe} | 1.0 | 30 | μmhos |
| SWITCHING CHARACTERISTICS | · | | | |
| Delay Time (V _{CC} = 30 Vdc, V _{EB} = 2.0 Vdc, | td | | 15 | ns |
| Rise Time I _C = 150 mAdc, I _{B1} = 15 mAdc) | t _r | _ | 20 | ns |
| Storage Time (V _{CC} = 30 Vdc, I _C = 150 mAdc, | t _s | | 225 | ns |
| Fall Time IB1 = IB2 = 15 mAdc) | tf | | 30 | ns |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 600 | mAdo |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | •€ |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBT4403

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

SWITCHING TRANSISTOR

PNP SILICON

Refer to 2N4402 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|----------------------|------------------------------|--------------------|--------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 40 | | Vdc |
| Collector-Base Breakdown Voltage (I _C = 0.1 mAdc, I _E = 0) | V(BR)CBO | 40 | | Vdc |
| Emitter-Base Breakdown Voltage (IE = 0.1 mAdc, IC = 0) | V(BR)EBO | 5.0 | | Vdc |
| Base Cutoff Current (VCE = 35 Vdc, VBE = 0.4 Vdc) | BEV | _ | 0.1 | μAdc |
| Collector Cutoff Current (VCE = 35 Vdc, VBE = 0.4 Vdc) | CEX | | 0.1 | μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 0.1 mAdc, V _{CE} = 1.0 Vdc) (IC = 1.0 mAdc, V _{CE} = 1.0 Vdc) (IC = 10 mAdc, V _{CE} = 1.0 Vdc) (IC = 150 mAdc, V _{CE} = 2.0 Vdc)(1) (IC = 500 mAdc, V _{CE} = 2.0 Vdc)(1) | hFE | 30 60 100 100 20 | — — 300 — | _ |
| Collector-Emitter Saturation Voltage(1) (I _C = 150 mAdc, I _B = 15 mAdc) (I _C = 500 mAdc, I _B = 50 mAdc) | VCE(sat) | 1 1 | 0.4 0.75 | Vdc |
| Base-Emitter Saturation Voltage(1) (I _C = 150 mAdc, I _B = 15 mAdc) (I _C = 500 mAdc, I _B = 50 mAdc) | V _{BE(sat)} | 0.75 — | 0.95 1.3 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 20 mAdc, VCE = 10 Vdc, f = 100 MHz) | fΤ | 200 | | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, IE = 0, f = 140 kHz) | C _{cb} | - | 8.5 | pF |
| Emitter-Base Capacitance (VBE = 0.5 Vdc, IC = 0, f = 140 kHz) | C _{eb} | 1 | 30 | pF |
| Input Impedance (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{ie} | 1.5k | 15k | ohms |
| Voltage Feedback Ratio (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{re} | 0.1 | 8.0 | X 10-4 |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | . h _{fe} | 60 | 500 | _ |
| Output Admittance (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | hoe | 1.0 | 100 | μmhos |
| SWITCHING CHARACTERISTICS | | | | |
| Delay Time (V _{CC} = 30 Vdc, V _{BE} = 2.0 Vdc, | td | _ | 15 | ns |
| Rise Time IC = 150 mAdc, IB1 = 15 mAdc) | t _r | - | 20 | ns |
| Storage Time (V _{CC} = 30 Vdc, I _C = 150 mAdc, | t _S | | 225 | ns |
| Fall Time IB1 = IB2 = 15 mAdc) | tf | | 30 | ns |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MMBT5086,87

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

LOW NOISE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 50 | Vdc |
| Collector-Base Voltage | V _{CBO} | 50 | Vdc |
| Emitter-Base Voltage | V _{EBO} | 3.0 | Vdc |
| Collector Current — Continuous | lc | 50 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | ReJA | 357 | °C/W |

*Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

Refer to 2N5088 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|----------------------|----------------------|------------|------------|------|
| OFF CHARACTERISTICS | | | _ | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) | | V(BR)CEO | 50 | - | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0) | | V _{(BR)CBO} | 50 | - | Vdc |
| Collector Cutoff Current (VCB = 10 Vdc, IE = 0) (VCB = 35 Vdc, IE = 0) | | ІСВО | - | · 10 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 100 μAdc, V _{CE} = 5.0 Vdc) | MMBT5086 MMBT5087 | hFE | 150 250 | 500 800 | _ |
| (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc) | MMBT5086 MMBT5087 | | 150 250 | = | |
| (IC = 10 mAdc, V _{CE} = 5.0 Vdc) | MMBT5086 MMBT5087 | | 150 250 | _ | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | | V _{CE(sat)} | | 0.3 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | - | V _{BE(sat)} | | 0.85 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 500 µAdc, V _{CE} = 5.0 Vdc, f = 20 MHz) | | fT | 40 | - | MHz |
| Output Capacitance (VCB = 5.0 Vdc, IE = 0, f = 100 kHz) | | C _{obo} | _ | 4.0 | ρF |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | MMBT5086 MMBT5087 | h _{fe} | 150 250 | 600 900 | - |
| Noise Figure (IC = 20 mAdc, V_{CE} = 5.0 Vdc, R_S = 10 k Ω , f = 10 Hz to 15.7 kHz) | MMBT5086 MMBT5087 | NF | = | 3.0 2.0 | dB |
| (I _C = 100 μ Adc, V _{CE} = 5.0 Vdc, R _S = 3.0 k Ω , f = 1.0 kHz) | MMBT5086 MMBT5087 | | _ | 3.0 2.0 | |

| | | Value | | |
|--------------------------------|------------------|----------|----------|------|
| Rating | Symbol | MMBT5088 | MMBT5089 | Unit |
| Collector-Emitter Voltage | VCEO | 30 | 25 | Vdc |
| Collector-Base Voltage | V _{CBO} | 35 | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 4.5 | | Vdc |
| Collector Current — Continuous | lc | 50 | | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBT5088,89

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

LOW NOISE TRANSISTOR

NPN SILICON

Refer to MPSA18 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|----------------------|----------------------|------------|--------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) | MMBT5088 MMBT5089 | V(BR)CEO | 30 25 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μ Adc, IE = 0) | MMBT5088 MMBT5089 | V(BR)CBO | 35 30 | = | Vdc |
| Collector Cutoff Current (VCB = 20 Vdc, IE = 0) (VCB = 15 Vdc, IE = 0) | MMBT5088 MMBT5089 | ІСВО | = | 50 50 | nAdc |
| Emitter Cutoff Current (VEB(off) = 3.0 Vdc, I $_{\rm C}$ = 0) (VEB(off) = 4.5 Vdc, I $_{\rm C}$ = 0) | MMBT5088 MMBT5089 | IEBO | = | 50 100 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 100 μ Adc, V _{CE} = 5.0 Vdc) | MMBT5088 MMBT5089 | hFE | 300 400 | 900 1200 | - |
| (I _C = 1.0 mAdc, V_{CE} = 5.0 Vdc) | MMBT5088 MMBT5089 | | 350 450 | _ | |
| (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) | MMBT5088 MMBT5089 | | 300 400 | _ | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 r | mAdc) | V _{CE(sat)} | _ | 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAd | c) | V _{BE(sat)} | _ | 0.8 | Vdc |
| SMALL SIGNAL CHARACTERISTICS | | <u> </u> | | | |
| Current-Gain — Bandwidth Product (IC = 500 µAdc, VCE = 5.0 Vdc, f = 20 MHz) | | fT | 50 | - | MHz |
| Collector-Base Capacitance (VCB = 5.0 Vdc, I _E = 0, f = 100 kHz emitter guarded) | | C _{cb} | _ | 4.0 | pF |
| Emitter-Base Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 100 kHz collector guarded) | | C _{eb} | _ | 10 | pF |
| Small Signal Current Gain {IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz} | MMBT5088 MMBT5089 | h _{fe} | 350 450 | 1400 1800 | |
| Noise Figure $(I_C = 100 \mu Adc, V_{CE} = 5.0 Vdc, R_S = 10 k\Omega,$ $f = 10 Hz to 15.7 Hz)$ | MMBT5088 MMBT5089 | NF | = | 3.0 2.0 | dB |

MMBT5401

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

HIGH VOLTAGE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Coilector-Emitter Voltage | VCEO | 150 | Vdc |
| Collector-Base Voltage | V _{CBO} | 160 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 500 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | ReJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

Refer to 2N5401 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|----------------|-------------|--------------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 150 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 160 | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | V(BR)EBO | 5.0 | - | Vdc |
| Collector Cutoff Current (VCB = 100 Vdc, IE = 0) (VCB = 100 Vdc, IE = 0, TA = 150°C) | ІСВО | _ | 50 50 | nAdc µAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 1.0 mAdc, VCE = 5.0 Vdc) (IC = 10 mAdc, VCE = 5.0 Vdc) (IC = 50 mAdc, VCE = 5.0 Vdc) | hFE | 50 60 50 | 240 | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc) | VCE(sat) | = | 0.20 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc) | VBE(sat) | = | 1.0 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | fτ | 100 | 300 | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | C _{obo} | _ | 6.0 | pF |
| Small Signal Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{fe} | 40 | 200 | _ |
| Noise Figure (I _C = 200 μ Adc, V _{CE} = 5.0 Vdc, R _S = 10 ohms, f = 10 Hz to 15.7 kHz) | NF | _ | 8.0 | dB |

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 140 | Vdc |
| Collector-Base Voltage | V _{CBO} | 160 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | Vdc |
| Collector Current — Continuous | lc lc | 600 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBT5550

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

HIGH VOLTAGE TRANSISTOR

NPN SILICON

Refer to 2N5550 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|----------------|--------------|--------------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 140 | | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _C = 0) | V(BR)CBO | 160 | - | Vdc |
| Emitter-Base Breakdown Voltage (ΙΕ = 10 μAdc, Ι _C = 0) | V(BR)EBO | 6.0 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 100 Vdc, I _E = 0) (V _{CB} = 100 Vdc, I _E = 0, T _A = 100°C) | ІСВО | = | 100 100 | nAdc μAdc |
| Emitter Cutoff Current (VEB = 4.0 Vdc, IC = 0) | IEBO | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 1.0 mAdc, VCE = 5.0 Vdc) (IC = 10 mAdc, VCE = 5.0 Vdc) (IC = 50 mAdc, VCE = 5.0 Vdc) | ptE | 60 60 20 | 250 | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) (IC = 50 mAdc, Ig = 5.0 mAdc) | VCE(sat) | _ | 0.15 0.25 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc) | V _{BE(sat)} | = | 1.0 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | , | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | fT | 100 | 300 | MHz |
| Output Capacitance {VCB = 10 Vdc, I _E = 0, f = 1.0 MHz} | C _{obo} | | 6.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | C _{ibo} | _ | 30 | pF |

MMBT6427

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

DARLINGTON TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | VCBO | 40 | Vdc |
| Emitter-Base Voltage | V _{EBO} | 12 | Vdc |
| Collector Current — Continuous | Ic | 500 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | RAJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

Refer to 2N8426 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|----------------------|----------------------------|-------------------------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage $\{l_C = 10 \text{ mAdc, } l_B = 0\}$ | V(BR)CEO | 40 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 40 | - | Vdc |
| Emitter-Base Breakdown Voltage (IC = 10 μAdc, IC = 0) | V(BR)EBO | 12 | _ | Vdc |
| Collector Cutoff Current (VCE = 25 Vdc, IB = 0) | ICEO | | 1.0 | μAdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0) | ICBO | | 50 | nAdc |
| Emitter Cutoff Current (V _{BE} = 10 Vdc, I _C = 0) | IEBO | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 10 mAdc, VCE = 5.0 Vdc) (IC = 100 mAdc, VCE = 5.0 Vdc) (IC = 500 mAdc, VCE = 5.0 Vdc) | hfE | 10,000 20,000 14,000 | 100,000 200,000 140,000 | - |
| Collector-Emitter Saturation Voltage (I _C = 50 mAdc, I _B = 0.5 mAdc) (I _C = 500 mAdc, I _B = 0.5 mAdc) | VCE(sat) | _ | 1.2 1.5 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 500 mAdc, I _B = 0.5 mAdc) | V _{BE(sat)} | _ | 2.0 | Vdc |
| Base-Emitter On Voltage (IC = 50 mAdc, VCE = 5.0 Vdc) | V _{BE(on)} | _ | 1.75 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | _ | 7.0 | pF |
| Input Capacitance (V _{BE} = 0.5, I _C = 0, f = 1.0 MHz) | C _{ibo} | _ | 15 | pF |
| Current Gain — High Frequency (IC = 10 mAdc, VCE = 5.0 Vdc, f = 100 MHz) | h _{fe} | 1.3 | _ | Vdc |
| Noise Figure (IC = 1.0 mAdc, VCE = 5.0 Vdc, RS = 100 k Ω , f = 1.0 kHz to 15.7 kHz) | NF | _ | 10 | dB |

| | | Va | | |
|--------------------------------|------------------|----------|----------|------|
| Rating | Symbol | MMBT6428 | MMBT6429 | Unit |
| Collector-Emitter Voltage | VCEO | 50 | 45 | Vdc |
| Collector-Base Voltage | V _{CBO} | 60 | 55 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | | Vdc |
| Collector Current — Continuous | lc | 200 | | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | •℃ |
| *Thermal Resistance Junction to Ambient | RAIA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBT6428,29

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MPSA18 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|----------------------|----------------------|------------|-------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) (I _C = 1.0 mAdc, I _B = 0) | MMBT6428 MMBT6429 | V(BR)CEO | 50 45 | = | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.1 mAdc, IE = 0) (IC = 0.1 mAdc, IE = 0) | MMBT6428 MMBT6429 | V(BR)CBO | 60 55 | = | Vdc |
| Collector Cutoff Current (VCE = 30 Vdc) | | ICEO | _ | 0.1 | μAdc |
| Collector Cutoff Current (VCB = 30 Vdc, !E = 0) | | Ісво | | 0.01 | μAdc |
| Emitter Cutoff Current (VEB = 5.0 Vdc, IC = 0) | | IEBO | _ | 0.01 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 0.01 mAdc, V _{CE} = 5.0 Vdc) | MMBT6428 MMBT6429 | hFE | 250 500 | = | - |
| (I _C = 0.1 mAdc, V _{CE} = 5.0 Vdc) | MMBT6428 MMBT6429 | | 250 500 | 650 1250 | |
| (IC = 1.0 mAde, V_{CE} = 5.0 Vdc) | MMBT6428 MMBT6429 | | 250 500 | _ | |
| (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) | MMBT6428 MMBT6429 | | 250 500 | | |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 0.5 mAdc) (I _C = 100 mAdc, I _B = 5.0 mAdc) | | V _{CE(sat)} | _ | 0.2 0.6 | Vdc |
| Base-Emitter On Voltage (IC = 1.0 mAdc, VCE = 5.0 Vdc) | | VBE(on) | 0.56 | 0.66 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 1.0 mAdc, V _{CE} = 5.0 Vdc, f = 100 MHz) | | fT | 100 | 700 | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | | C _{obo} | - | 3.0 | pF |
| Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | | Cibo | _ | 8.0 | pF |

MMBT6517

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

HIGH VOLTAGE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 350 | Vdc |
| Collector-Base Voltage | V _{CBO} | 350 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Base Current | IВ | 250 | mA |
| Collector Current — Continuous | lc | 500 | mA |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|-------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _B JA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

Refer to 2N6517 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|-----------------|----------------------------|-----------------------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mA) | V(BR)CEO | 350 | - | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μA) | V(BR)CBO | 350 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µA) | V(BR)EBO | 6.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 250 V) | ІСВО | _ | 50 | nA |
| Emitter Cutoff Current (VEB = 5.0 V) | lEBO | _ | 50 | nA |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 1.0 mA, V _{CE} = 10 V) (IC = 10 mA, V _{CE} = 10 V) (IC = 30 mA, V _{CE} = 10 V) (IC = 50 mA, V _{CE} = 10 V) (IC = 100 mA, V _{CE} = 10 V) | hFE | 20 30 30 20 15 | 200 100 | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mA, I _B = 1.0 mA) (I _C = 20 mA, I _B = 2.0 mA) (I _C = 30 mA, I _B = 3.0 mA) (I _C = 50 mA, I _B = 5.0 mA) | VCE(sat) | 1111 | 0.30 0.35 0.50 1.0 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mA, I _B = 1.0 mA) (I _C = 20 mA, I _B = 2.0 mA) (I _C = 30 mA, I _B = 3.0 mA) | VBE(sat) | = | 0.75 0.85 0.90 | Vdc |
| Base-Emitter On Voltage (IC = 100 mA, VCE = 10 V) | VBE(on) | _ | 2.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (I _C = 10 mA, V _{CE} = 20 V, f = 20 MHz) | ÍΤ | 40 | 200 | MHz |
| Collector-Base Capacitance (VCB = 20 V, f = 1.0 MHz) | C _{cb} | - | 6.0 | ρF |
| Emitter-Base Capacitance (VEB = 0.5 V, f = 1.0 MHz) | C _{eb} | _ | 80 | pF |

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 350 | Vdc |
| Collector-Base Voltage | V _{CBO} | 350 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Base Current | l _B | 250 | mA |
| Collector Current — Continuous | lc lc | 500 | mA |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | ReJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBT6520

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

HIGH VOLTAGE TRANSISTOR

PNP SILICON

Refer to 2N6520 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|---------------------|----------------------------|-----------------------------|------|
| OFF CHARACTERISTICS | | | | .: |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mA) | V(BR)CEO | 350 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μA) | V(BR)CBO | 350 | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µA) | V(BR)EBO | 5.0 | - | Vdc |
| Collector Cutoff Current (VCB = 250 V) | ſСВО | _ | 50 | nA |
| Emitter Cutoff Current (VEB = 4.0 V) | lEBO | _ | 50 | nA |
| ON CHARACTERISTICS | - | | | |
| DC Current Gain (I _C = 1.0 mA, V _{CE} = 10 V) (I _C = 10 mA, V _{CE} = 10 V) (I _C = 30 mA, V _{CE} = 10 V) (I _C = 50 mA, V _{CE} = 10 V) (I _C = 100 mA, V _{CE} = 10 V) | hFE | 20 30 30 20 15 | 200 100 | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mA, I _B = 1.0 mA) (I _C = 20 mA, I _B = 2.0 mA) (I _C = 30 mA, I _B = 3.0 mA) (I _C = 50 mA, I _B = 5.0 mA) | VCE(sat) | _ _ _ | 0.30 0.35 0.50 1.0 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mA, I _B = 1.0 mA) (I _C = 20 mA, I _B = 2.0 mA) (I _C = 30 mA, I _B = 3.0 mA) | VBE(sat) | = - | 0.75 0.85 0.90 | Vdc |
| Base-Emitter On Voltage (IC = 100 mA, V _{CE} = 10 V) | V _{BE(on)} | | | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mA, VCE = 20 V, f = 20 MHz) | fT | 40 | 200 | MHz |
| Collector-Base Capacitance (V _{CB} = 20 V, f = 1.0 MHz) | Ссь | _ | 6.0 | pF |
| Emitter-Base Capacitance (VEB = 0.5 V, f = 1.0 MHz) | C _{eb} | _ | 100 | pF |

MMBT6543

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 25 | Vdc |
| Collector-Base Voltage | V _{CBO} | 35 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | lc | 50 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | •€ |
| *Thermal Resistance Junction to Ambient | RAJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

Refer to MPS6543 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Symbol | Min | Тур | Max | Unit |
|----------------------|--|--|---|---|
| | | | | |
| V(BR)CEO | 25 | _ | 1 | Vdc |
| V(BR)CBO | 35 | _ | _ | Vdc |
| V(BR)EBO | 3.0 | _ | _ | Vdc |
| Ісво | 1 | _ | 0.1 | μAdc |
| lEBO | ı | _ | 1.0 | μAdc |
| | | | | |
| hFE | 25 | 60 | | _ |
| V _{CE(sat)} | 1 | 200 | 350 | mVdc |
| V _{BE(sat)} | _ | 750 | 950 | mVdc |
| | | | | |
| fT | 750 | 1100 | _ | MHz |
| C _{obo} | _ | 0.8 | 1.0 | pF |
| rb'C _C | _ | | 9.5 | ps |
| | V(BR)CEO V(BR)CBO V(BR)EBO ICBO IEBO hFE VCE(sat) VBE(sat) fT Cobo | V(BR)CEO 25 V(BR)CBO 35 V(BR)EBO 3.0 ICBO — IEBO — hFE 25 VCE(sat) — VBE(sat) — fT 750 Cobo — | V(BR)CEO 25 — V(BR)CBO 35 — V(BR)EBO 3.0 — ICBO — — IEBO — — hFE 25 60 VCE(sat) — 200 VBE(sat) — 750 fT 750 1100 Cobo — 0.8 | V(BR)CEO 25 — — V(BR)CBO 35 — — V(BR)EBO 3.0 — — ICBO — 0.1 — IEBO — — 1.0 hFE 25 60 — VCE(sat) — 200 350 VBE(sat) — 750 950 fT 750 1100 — Cobo — 0.8 1.0 |

(2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| | | Value | | |
|--------------------------------|--------|---------|---------|------|
| Rating | Symbol | MMBTA05 | MMBTA06 | Unit |
| Collector-Emitter Voltage | VCEO | 60 | 80 | Vdc |
| Collector-Base Voltage | VCBO | 60 | 80 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | | Vdc |
| Collector Current — Continuous | lc | 5 | 500 | |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBTA05,06

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

DRIVER TRANSISTOR

NPN SILICON

| Characterist | ic | Symbol | Min | Max | Unit |
|--|--------------------|---------------------|----------|------------|------|
| OFF CHARACTERISTICS | | | | | • |
| Collector-Emitter Breakdown Voltage(1) (I _C = 1.0 mAdc, I _B = 0) | MMBTA05 MMBTA06 | V(BR)CEO | 60 80 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μ Adc, I _C = 0) | | V(BR)EBO | 4.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 60 Vdc, IB = 0) | | CEO | | 0.1 | μAdc |
| Collector Cutoff Current (VCB = 60 Vdc, I _E = 0) (VCB = 80 Vdc, I _E = 0) | MMBTA05 MMBTA06 | ІСВО | _ | 0.1 0.1 | μAdc |
| ON CHARACTERISTICS | | | | <u> </u> | · |
| DC Current Gain (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) (I _C = 100 mAdc, V _{CE} = 1.0 Vdc) | | hFE | 50 50 | _ | _ |
| Collector-Emitter Saturation Voltage (IC = 100 mAdc, Ig = 10 mAdc) | | VCE(sat) | _ | 0.25 | Vdc |
| Base-Emitter On Voltage (IC = 100 mAdc, VCE = 1.0 Vdc) | | V _{BE(on)} | | 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product(2) (IC = 10 mA, VCE = 2.0 V, f = 100 MHz) | | fT | 100 | _ | MHz |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

⁽²⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.

MMBTA13,14

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

DARLINGTON AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCES | 30 | Vdc |
| Collector-Base Voltage | V _{CBO} | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 10 . | Vdc |
| Collector Current — Continuous | lc | 300 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | Reja | 357 | •c/w |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

Refer to 2N6426 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|--------------------|----------------------|------------------|-----|----------------|
| OFF CHARACTERISTICS | | | | _ | |
| Collector-Emitter Breakdown Voltage (I _C = 100 μAdc, I _B = 0) | | V(BR)CES | 30 | _ | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, !E = 0) | | СВО | _ | 100 | nAdc |
| Emitter Cutoff Current (VBE = 10 Vdc, IC = 0) | | ¹ EBO | - | 100 | nAdc |
| ON CHARACTERISTICS(1) | | · | | · | |
| DC Current Gain (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) | MMBTA13 MMBTA14 | hFE | 5000 10,000 | = | _ |
| (IC = 100 mAdc, VCE = 5.0 Vdc) | MMBTA13 MMBTA14 | | 10,000 20,000 | _ | |
| Collector-Emitter Saturation Voltage (IC = 100 mAdc, Ig = 0.1 mAdc) | | V _{CE(sat)} | _ | 1.5 | Vdc |
| Base-Emitter On Voltage (IC = 100 mAdc, VCE = 5.0 Vdc) | | VBE | | 2.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | _ | | , - |
| Current-Gain — Bandwidth Product(2) (IC = 10 mAdc, VCE = 5.0 Vdc, f = 100 MHz) | | fT | 125 | | MHz |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

⁽²⁾ fr = |hfe| • ftest.

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Emitter-Base Voltage | V _{EBO} | 4.0 | Vdc |
| Collector Current — Continuous | Ic | 100 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBTA20

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

GENERAL PURPOSE AMPLIFIER

NPN SILICON

Refer to MPS3904 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|-----|------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 40 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 µAdc, I _C = 0) | V(BR)EBO | 4.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0) | СВО | _ | 100 | nAdc |
| ON CHARACTERISTICS | | | • | |
| DC Current Gein (IC = 5.0 mAdc, VCE = 10 Vdc) | hFE | 40 | 400 | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | VCE(sat) | - | 0.25 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 5.0 mAdc, VCE = 10 Vdc, f = 100 MHz) | fτ | 125 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | C _{obo} | _ | 4.0 | pF |

MMBTA42,43

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

HIGH VOLTAGE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| | | Va | | |
|--------------------------------|--------|---------|---------|------|
| Rating | Symbol | MMBTA42 | MMBTA43 | Unit |
| Collector-Emitter Voltage | VCEO | 300 | 200 | Vdc |
| Collector-Base Voltage | VCBO | 300 | 200 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | 6.0 | Vdc |
| Collector Current — Continuous | lc | 500 | | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/℃ |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

Refer to MPSA42 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|--|-----------------|----------------------|------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | MMBTA42 MMBTA43 | V(BR)CEO | 300 200 | = | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0) | MMBTA42 MMBTA43 | V(BR)CBO | 300 200 | = | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 6.0 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 200 Vdc, I _E = 0) (V _{CB} = 160 Vdc, I _E = 0) | MMBTA42 MMBTA43 | СВО | | 0.1 0.1 | μAdc |
| Emitter Cutoff Current (VBE = 6.0 Vdc , IC = 0) (VBE = 4.0 Vdc , IC = 0) | MMBTA42 MMBTA43 | IEBO | = | 0.1 0.1 | μAdc |
| ON CHARACTERISTICS(1) | | | | · | |
| DC Current Gein (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc) (I _C = 30 mAdc, V _{CE} = 10 Vdc) | Both Types Both Types MMBTA42 MMBTA43 | hFE | 25 40 40 40 | = - | _ |
| Collector-Emitter Saturation Voltage (I _C = 20 mAdc, I _B = 2.0 mAdc) | MMBTA42 MMBTA43 | VCE(sat) | | 0.5 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 20 mAdc, !g = 2.0 mAdc) | | VBE(sat) | _ | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz) | | fT | 50 | _ | MHz |
| Collector-Base Capacitance (VCB = 20 Vdc, IE = 0, f = 1.0 MHz) | MMBTA42 MMBTA43 | C _{cb} | _ | 3.0 4.0 | pF |

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

| Rating | Symbol | MMBTA55 | MMBTA56 | Unit |
|--------------------------------|------------------|---------|---------|------|
| Collector-Emitter Voltage | VCEO | 60 | 80 | Vdc |
| Collector-Base Voltage | V _{CBO} | 60 | 80 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | | Vdc |
| Collector Current — Continuous | lc | 500 | | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C , |
| *Thermal Resistance Junction to Ambient | ReJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBTA55,56

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

DRIVER TRANSISTOR

PNP SILICON

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------|---------------------|----------|---|-------|
| OFF CHARACTERISTICS | | | | *** | · |
| Collector-Emitter Breakdown Voltage(1) (I _C = 1.0 mAdc, I _B = 0) | MMBTA55 MMBTA56 | V(BR)CEO | 60 80 | = | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 μ Adc, IC = 0) | | V(BR)EBO | 4.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 60 Vdc, IB = 0) | | (CEO | _ | 0.1 | μAdc |
| Collector Cutoff Current (VCB = 60 Vdc, IE = 0) (VCB = 80 Vdc, IE = 0) | MMBTA55 MMBTA56 | ІСВО | _ | 0.1 0.1 | μAdc |
| ON CHARACTERISTICS | | | ,- | *************************************** | |
| DC Current Gain ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 100$ mAdc, $V_{CE} = 1.0$ Vdc) | | hFE | 50 50 | = | _ |
| Collector-Emitter Saturation Voltage (I _C = 100 mAdc, I _B = 10 mAdc) | | VCE(sat) | _ | 0.25 | . Vdc |
| Base-Emitter On Voltage (IC = 100 mAdc, VCE = 1.0 Vdc) | | V _{BE(on)} | | 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product(2) (IC = 100 mAdc, VCE = 1.0 Vdc, f = 100 MHz) | | fī | 50 | _ | MHz |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

⁽²⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.

MMBTA63 MMBTA64

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

DARLINGTON TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|--------|-------|------|
| Collector-Emitter Voltage | VCES | 30 | Vdc |
| Collector-Base Voltage | VCBO | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 10 | Vdc |
| Collector Current — Continuous | lc | 500 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | RAJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

Refer to MPSA75 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|--|---------------------|-------------------------------------|-------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 100 μAdc) | | V(BR)CES | 30 | 1 | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc) | | ¹ CBO | - | 100 | nAdc |
| Emitter Cutoff Current (VBE = 10 Vdc) | | IEBO | - | 100 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(1) (IC = 10 mAdc, V _{CE} = 5.0 Vdc) (IC = 10 mAdc, V _{CE} = 5.0 Vdc) (IC = 100 mAdc, V _{CE} = 5.0 Vdc) (IC = 1000 mAdc, V _{CE} = 5.0 Vdc) | MMBTA63 MMBTA64 MMBTA63 MMBTA64 | phe | 5,000 10,000 10,000 20,000 | - - - | _ |
| Collector-Emitter Saturation Voltage (IC = 100 mAdc, IB = 0.1 mAdc) | | VCE(sat) | _ | 1.5 | Vdc |
| Base-Emitter On Voltage (IC = 100 mAdc, VCE = 5.0 Vdc) | | V _{BE(on)} | _ | 2.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 50 Vdc, f = 100 MHz) | | fŢ | 125 | _ | MHz |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| Rating | Symbol | Value | Unit |
|--------------------------------|--------|-------|------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | ıc | 100 | mAdc |

THERMAL CHARACTERISTICS

| THE MALE OF PARTIE OF THE OTHER | | | |
|---|------------------|------------|-------------|
| Characteristic | Symbol | Max | Unit |
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | ReJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBTA70

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

Refer to 2N5086 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|------------------|-----|------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 40 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 µAdc, IC = 0) | V(BR)EBO | 4.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0) | ІСВО | _ | 100 | nAdc |
| ON CHARACTERISTICS | | | • | |
| DC Current Gain (I _C = 5.0 mAdc, V _{CE} = 10 Vdc) | hFE | 40 | 400 | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | VCE(sat) | _ | 0.25 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (I _C = 5.0 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | fτ | 125 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | _ | 4.0 | pF |

MMBTA92,93

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

HIGH VOLTAGE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | MMBTA92 | MMBTA93 | Unit |
|--------------------------------|------------------|---------|---------|------|
| Collector-Emitter Voltage | VCEO | 300 | 200 | Vdc |
| Collector-Base Voltage | V _{CBO} | 300 | 200 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | 5.0 | Vdc |
| Collector Current — Continuous | lc | 500 | | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | ReJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

Refer to MPSA92 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------------|----------------------|------------|--------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | MMBTA92 MMBTA93 | V(BR)CEO | 300 200 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0) | MMBTA92 MMBTA93 | V(BR)CBO | 300 200 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 200 Vdc, I _E = 0) (V _{CB} = 160 Vdc, I _E = 0) | MMBTA92 MMBTA93 | ІСВО | | 0.25 0.25 | μAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | | lEBO | _ | 0.1 | μAdc |
| ON CHARACTERISTICS(1) | | | | | _ |
| DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc) | Both Types Both Types | hFE | 25 40 | = | _ |
| $(I_C = 30 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})$ | MMBTA92 MMBTA93 | | 25 25 | _ | |
| Collector-Emitter Saturation Voltage (I _C = 20 mAdc, I _B = 2.0 mAdc) | MMBTA92 MMBTA93 | VCE(sat) | = | 0.5 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 20 mAdc, IB = 2.0 mAdc) | | V _{BE(sat)} | _ | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz) | | ĺΤ | 50 | | MHz |
| Collector-Base Capacitance (VCB = 20 Vdc, I _E = 0, f = 1.0 MHz) | MMBTA92 MMBTA93 | C _{cb} | <u>-</u> _ | 6.0 8.0 | pF |

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

| Rating | Symbol | Value | Unit |
|---------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 25 | Vdc |
| Collector-Base Voltage | V _{CBO} | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{OJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBTH10

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

VHF/UHF TRANSISTOR

NPN SILICON

Refer to MPSH10 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|----------------------|------|------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) | V(BR)CEO | 25 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 µAdc, I _E = 0) | V(BR)CBO | 30 | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 3.0 | - | Vdc |
| Collector Cutoff Current (VCB = 25 Vdc, I _E = 0) | ICBO | _ | 100 | nAdc |
| Emitter Cutoff Current (VBE = 2.0 Vdc, IC = 0) | ¹ EBO | _ | 100 | nAdc |
| ON CHARACTERISTICS | - | | 4. | |
| DC Current Gain (IC = 4.0 mAdc, VCE = 10 Vdc) | hFE | 60 | - | - |
| Collector-Emitter Saturation Voltage (I _C = 4.0 mAdc, I _B = 0.4 mAdc) | V _{CE(sat)} | _ | 0.5 | Vdc |
| Base-Emitter On Voltage (I _C = 4.0 mAdc, V _{CE} = 10 Vdc) | V _{BE} | _ | 0.95 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | ** | | · | 1 |
| Current-Gain — Bandwidth Product (IC = 4.0 mAdc, VCE = 10 Vdc, f = 100 MHz) | fT | 650 | - | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | C _{cb} | _ | 0.7 | pF |
| Common-Base Feedback Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz) | C _{rb} | 0.35 | 0.65 | pF |
| Collector Base Time Constant (IC = 4.0 mAdc, V _{CB} = 10 Vdc, f = 31.8 MHz) | rb'C _C | _ | 9.0 | ps |

MMBTH24

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

VHF MIXER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|--------|-------|------|
| Collector-Emitter Voltage | VCEO | 30 | Vdc |
| Collector-Base Voltage | VCBO | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | lc | 100 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | RAJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|-----------------|-----|------|------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) | V(BR)CEO | 30 | 1 | 1 | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, I _E = 0) | V(BR)CBO | 40 | 1 | 1 | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 4.0 | 1 | 1 | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) | ІСВО | _ | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 8.0 mAdc, VCE = 10 Vdc) | hFE | 30 | _ | _ | _ |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product(1) (I _C = 8.0 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | fT | 400 | 620 | _ | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | C _{cb} | _ | 0.25 | 0.36 | pF |
| Conversion Gain | | - | | | dB |
| (213 MHz to 45 MHz) (IC = 8.0 mAdc, V _{CC} = 20 Vdc, Oscillator Injection = 150 mVrms) (60 MHz to 45 MHz) | c _G | 19 | 24 | _ | |
| (IC = 8.0 mAdc, VCC = 20 Vdc, Oscillator Injection = 150 mVrms) | 1 | 24 | 29 | - | |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| Rating | Symbol | Value | Unit |
|---------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Base Voltage | V _{CBO} | 20 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit | | | | |
|---|--------|------------|-------------|--|--|--|--|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C | | | | |
| Storage Temperature | Tstg | 150 | •€ | | | | |
| *Thermal Resistance Junction to Ambient | RAJA | 357 | °C/W | | | | |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

MMBTH81

CASE 318-02/03, STYLE 6 SOT-23 (TO-236AA/AB)

UHF/VHF TRANSISTOR

PNP SILICON

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|---------------------|-----|-----|------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 20 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 20 | _ | _ | Vdc |
| (IE = 10 µAdc, IC = 0) | V(BR)EBO | 3.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 10 Vdc, I _E = 0) | ICBO | _ | _ | 100 | nAdc |
| Emitter Cutoff Current (VBE = 2.0 Vdc, I_C = 0) | IEBO | - | _ | 100 | nAdc |
| ON CHARACTERISTICS | - <u></u> | | | | |
| DC Current Gain (I _C = 5.0 mAdc, V _{CE} = 10 Vdc) | hFE | 60 | _ | _ | - |
| Collector-Emitter Saturation Voltage (IC = 5.0 mAdc, IB = 0.5 mAdc) | VCE(sat) | _ | _ | 0.5 | Vdc |
| Base-Emitter On Voltage (IC = 5.0 mAdc, VCE = 10 Vdc) | V _{BE(on)} | _ | _ | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 5.0 mAdc, VCE = 10 Vdc, f = 100 MHz) | fŢ | 600 | _ | _ | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | C _{cb} | _ | _ | 0.85 | pF |
| Collector-Emitter Capacitance (Ig = 0, VCg = 10 Vdc, f = 1.0 MHz) | C _{ce} | _ | _ | 0.65 | pF |

MMBV105G

CASE 318-02/03, STYLE 8 SOT-23 (TO-236AA/AB)

VOLTAGE VARIABLE CAPACITANCE DIODE

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|-----------------|--------|-------|------|
| Reverse Voltage | VR | 30 | Vdc |
| Forward Current | F | 200 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | ℃ |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|-------------------|-----|-----|-----|--------|
| OFF CHARACTERISTICS | | | | | |
| Reverse Breakdown Voltage (I _R = 10 µAdc) | V _(BR) | 30 | _ | - | Vdc |
| Reverse Voltage Leakage Current (VR = 28 Vdc) | [†] R | _ | _ | 50 | nAdc |
| Series Inductance (f = 250 MHz) | Ls | _ | 3.0 | _ | nH |
| Diode Capacitance Temperature Coefficient (VR = 3.0 Vdc, f = 1.0 MHz) | тсс | _ | 280 | _ | ppm/°C |
| Diode Capacitance (V _R = 25 Vdc) | СТ | 1.8 | _ | 2.8 | pF |
| Capacitance (V _{R1} = 3.0 Vdc, V _{R2} = 25 Vdc, f = 1.0 MHz) | C3/C25 | 4.0 | _ | 6.0 | pF |

MMBV109

CASE 318-02/03, STYLE 8 SOT-23 (TO-236AA/AB)

VOLTAGE VARIABLE CAPACITANCE DIODE

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|-----------------|----------------|-------|------|
| Reverse Voltage | V _R | 30 | Vdc |
| Forward Current | ΙF | 200 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | Tstg | 150 | °C |
| *Thermal Resistance Junction to Ambient | RøJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|-------------------|-----|-----|-----|--------|
| OFF CHARACTERISTICS | | | | | |
| Reverse Breakdown Voltage (I _R = 10 μAdc) | V _(BR) | 30 | _ | _ | Vdc |
| Reverse Voltage Leakage Current (VR = 28 Vdc) | l _R | _ | - | 0.1 | μAdc |
| Series Inductance (f = 250 MHz) | LS | _ | 3.0 | _ | nH |
| Case Capacitance (f = 1.0 MHz) | cc | - | 0.1 | _ | pF |
| Diode Capacitance Temperature Coefficient (VR = 3.0 Vdc, f = 1.0 MHz) | тсс | _ | 280 | - | ppm/°C |
| Figure of Merit (V _R = 3.0 Vdc, f = 50 MHz) | Q | 280 | - | _ | _ |
| Diode Capacitance (V _R = 3.0 Vdc, f = 1.0 MHz) | CT | 26 | _ | 32 | pF |

MMBV2097 thru MMBV2109

CASE 318-02/03, STYLE 8 SOT-23 (TO-236AA/AB)

TUNING DIODE

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|-----------------|--------|-------|------|
| Reverse Voltage | ٧R | 30 | Vdc |
| Forward Current | ļέ | 20 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------|
| *Total Device Dissipation, T _A = 25°C Derate above 26°C | PD | 350 2.8 | mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------------|-----|------|-----|--------|
| OFF CHARACTERISTICS | | | | | |
| Reverse Breakdown Voltage (I _R = 10 µAdc) | V(BR) | 30 | _ | _ | Vdc |
| Reverse Voltage Leakage Current (VR = 25 Vdc) | I _R | _ | _ | 20 | nAdc |
| Series Inductance (f = 250 MHz, Lead Length ≈ 1/16*) | Ls | _ | 3.0 | _ | nH |
| Case Capacitance (f = 1.0 MHz, Lead Length ≈ 1/16") | cc | _ | 0.15 | _ | pF |
| Diode Capacitance Temperature Coefficient (VR = 4.0 Vdc, f = 1.0 MHz) | TCC | _ | 280 | 400 | ppm/°C |

| Device | | Diode Capacit 4.0 Vdc, f = 1 pF | | Q, Figure of Merit VR = 4.0 Vdc f = 50 MHz | TR, Tuning Ratio C ₂ /C ₃₀ f = 1.0 MHz | | Marking |
|-----------|------|---------------------------------------|------|--|--|-----|---------|
| | Min | Nom | Max | Min | Min | Max | Тор |
| MMBV-2101 | 6.1 | 6.8 | 7.5 | 450 | 2.5 | 3.3 | 4G |
| MMBV-2102 | 7.3 | 8.2 | 9.0 | 275 | 2.6 | 3.3 | 48 |
| MMBV-2103 | 9.0 | 10 | 11 | 400 | 2.6 | 3.3 | 4H |
| MMBV2104 | 10.8 | 12 | 13.2 | 275 | 2.6 | 3.3 | 4T |
| MMBV-2105 | 13.5 | 15 | 16.5 | 275 | 2.6 | 3.3 | 4U |
| MMBV-2106 | 16.2 | 18 | 19.8 | 250 | 2.7 | 3.3 | 4V |
| MMBV-2107 | 19.8 | 22 | 24.2 | 200 | 2.7 | 3.3 | 4W |
| MMBV-2108 | 24.3 | 27 | 29.7 | 300 | 2.7 | 3.3 | 4X |
| MMBV-2109 | 29.7 | 33 | 36.3 | 200 | 2.7 | 3.3 | 4.1 |

MMBV3102

CASE 318-02/03, STYLE 8 SOT-23 (TO-236AA/AB)

VOLTAGE VARIABLE CAPACITANCE DIODE

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|-----------------|--------|-------|------|
| Reverse Voltage | ٧R | 30 | Vdc |
| Forward Current | lF | 200 | mAdc |

THERMAL CHARACTERISTICS

| *************************************** | | | |
|---|------------------|------------|-------------|
| Characteristic | Symbol | Max | Unit |
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | RAJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|--|-----|-----|-----|--------|
| OFF CHARACTERISTICS | ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, | | • | | |
| Reverse Breakdown Voltage (IR = 10 µAdc) | V _(BR) | 30 | - | _ | Vdc |
| Reverse Voltage Leakage Current (VR = 25 Vdc) | l _R | _ | _ | 0.1 | μAdc |
| Series Inductance (f = 250 MHz) | LS | _ | 3.0 | _ | nH |
| Case Capacitance (f = 1.0 MHz) | cc | _ | 0.1 | _ | pF |
| Diode Capacitance Temperature Coefficient (VR = 3.0 Vdc, f = 1.0 MHz) | TCC | _ | 280 | _ | ppm/°C |
| Figure of Merit (V _R = 3.0 Vdc, f = 50 MHz) | a | 300 | _ | _ | - |
| Diode Capacitance (V _R = 3.0 Vdc, f = 1.0 MHz) | СТ | 20 | _ | 25 | pF |

MMBV3401

CASE 318-02/03, STYLE 8 SOT-23 (TO-236AA/AB)

SILICON PIN SWITCHING DIODE

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|-----------------|--------|-------|------|
| Reverse Voltage | VR | 35 | Vdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | RAJA | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|--------|-----|-----|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Reverse Breakdown Voltage (IR = 10 µAdc) | V(BR) | 35 | _ | _ | Vdc |
| Reverse Voltage Leakage Current (VR = 25 Vdc) | IR | | _ | 0.1 | μAdc |
| Series Inductance (f = 250 MHz) | Ls | _ | 3.0 | _ | nH |
| Series Resistance (I _F = 10 mAdc) | RS | _ | _ | 0.7 | Ohms |
| Case Capacitance (f = 1.0 MHz) | cc | _ | 0.1 | | pF |
| Diode Capacitance (V _R = 20 Vdc, f = 1.0 MHz) | СТ | _ | _ | 1.0 | pF |

MMBZ5226 thru MMBZ5257

CASE 318-02/03, STYLE 8 SOT-23 (TO-236AA/AB)

ZENER DIODES

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|-------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 357 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

Ve = 0.9 V Max @ le = 10 mA for all types.

| 0.0 0 10.00 | (@ lp = 10 m | Test | | Zener Voltage | | Max Zener | | |
|-------------|--------------|-----------|------|------------------|------|------------|----------------------|---------------------|
| | | Current | | , V _Z | 1 | Impedance | Max | @ ∨ _R |
| MMBZ | Marking | IZT mA | Min | Nominal | Max | @ lzτ Ω | I _R μΑ | VR V |
| 5226 | 8A | 5.0 | 3.1 | 3.3 | 3.5 | 175 | 25 | .95 |
| 5227 | 88 | 5.0 | 3.4 | 3.6 | 3.8 | 145 | 15 | .95 |
| 5228 | 8C | 5.0 | 3.7 | 3.9 | 4.1 | 120 | 10 | .95 |
| 5229 | 8D | 5.0 | 4.0 | 4.3 | 4.6 | 100 | 5 | .95 |
| 5230 | 8E | 5.0 | 4.4 | 4.7 | 5.0 | 80 | 3 | 2.0 |
| 5231 | 8F | 5.0 | 4.8 | 5.1 | 5.4 | 60 | 2 | 2.0 |
| 5232 | 8G | 5.0 | 5.2 | 5.6 | 6.0 | 40 | 1 | 2.0 |
| 5233 | 8H | 5.0 | 5.6 | 6.0 | 6.4 | 25 | 5 | 3.3 |
| 5234 | 8J | 5.0 | 5.8 | 6.2 | 6.6 | 10 | 3 | 4.0 |
| 5235 | 8K | 5.0 | 6.4 | 6.8 | 7.2 | 15 | 2 | 4.0 |
| 5236 | 8L | 5.0 | 7.0 | 7.5 | 7.9 | 15 | 1 | 5.0 |
| 5237 | 8M | 5.0 | 7.7 | 8.2 | 8.7 | 15 | 0.7 | 5.0 |
| 5238 | 8N | 5.0 | 8.2 | 8.7 | 9.2 | 15 | 0.6 | 5.5 |
| 5239 | 8P | 5.0 | 8.5 | 9.1 | 9.6 | 15 | 0.5 | 6.0 |
| 5240 | 80 | 5.0 | 9.4 | 10 | 10.6 | 20 | 0.2 | 7.0 |
| 5241 | 8R | 5.0 | 10.4 | 11 | 11.6 | 20 | 0.1 | 8.0 |
| 5242 | 85 | 5.0 | 11.4 | 12 | 12.7 | 25 | 0.1 | 8.0 |
| 5243 | 8T | 5.0 | 12.4 | 13 | 14.1 | 30 | 0.1 | 8.0 |
| 5244 | 8U | 5.0 | 13.2 | 14 | 14.8 | 30 | 0.1 | 9.5 |
| 5245 | 8V | 5.0 | 13.8 | 15 | 15.6 | 30 | 0.05 | 10.5 |
| 5246 | 8W | 5.0 | 15.3 | 16 | 17.1 | 40 | 0.05 | 11.2 |
| 5247 | 8X | 5.0 | 16.0 | 17 | 18.0 | 45 | 0.05 | 11.9 |
| 5248 | 8Y | 5.0 | 16.8 | 18 | 19.1 | 45 | 0.05 | 12.6 |
| 5249 | 8Z | 5.0 | 17.9 | 19 | 20.1 | 50 | 0.05 | 13.3 |
| 5250 | 81A | 5.0 | 18.8 | 20 | 21.2 | 55 | 0.05 | 14.0 |
| 5251 | 818 | 5.0 | 20.8 | 22 | 23.3 | 55 | 0.05 | 15.4 |
| 5252 | 81C | 5.0 | 22.8 | 24 | 25.6 | 70 | 0.05 | 16.8 |
| 5253 | 81D | 5.0 | 23.3 | 25 | 26.7 | 75 | 0.05 | 17.5 |
| 5254 | 81E | 2.0 | 25.1 | 27 | 28.9 | 80 | 0.05 | 18.9 |
| 5255 | 81F | 2.0 | 26.1 | 28 | 29.9 | 80 | 0.05 | 19.6 |
| 5256 | 81G | 2.0 | 28.0 | 30 | 32.0 | 80 | 0.05 | 21.0 |
| 5257 | 81H | 2.0 | 30.8 | 33 | 35.0 | 80 | 0.05 | 23.1 |

MXR3866

CASE 345-01, STYLE 1 SOT-89

RF TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|------|
| Collector-Emitter Voltage | VCEO | 30 | V |
| Collector-Base Voltage | V _{CBO} | 55 | ٧ |
| Emitter-Base Voltage | V _{EBO} | 3.5 | ٧ |
| Collector Current — Continuous | lc | 0.4 | Α |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|---------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Storage Temperature | T _{stg} | 150 | •€ |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 125 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 12 x 0.6 mm.

| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|-----------|-----|------|
| OFF CHARACTERISTICS | ··· | | · | • |
| Collector-Emitter Breakdown Voltage (I _C = 5.0 mA, R _{BE} = 10 Ω) | V(BR)CER | 55 | _ | V |
| Collector-Emitter Sustaining Voltage (I _C = 5.0 mA) | VCEO(sus) | 30 | _ | V |
| Collector-Base Breakdown Voltage (I _C = 0.1 mA) | V(BR)CBO | 55 | - | V |
| Emitter-Base Breakdown Voltage (I _E = 0.1 mA) | V(BR)EBO | 3.5 | _ | ٧ |
| Collector Cutoff Current (VCE = 28 V) | ICEO | | 20 | μΑ |
| Collector Cutoff Current (VCE = 55 V, VBE = 1.5 V) | ICEX | _ | 100 | μΑ |
| ON CHARACTERISTICS | | | • | |
| DC Current Gain (I _C = 0.36 A, V _{CE} = 5.0 V) (I _C = 0.05 A, V _{CE} = 5.0 V) | hFE | 5.0 10 | 200 | _ |
| Collector-Emitter Saturation Voltage (I _C = 100 mA, I _B = 20 mA) | VCE(sat) | _ | 1.0 | V |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 50 mA, VCE = 15 V, f = 200 MHz) | fT | 500 | _ | MHz |
| Output Capacitance (VCB = 30 V, f = 1.0 MHz) | C _{obo} | _ | 3.0 | pF |

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|------|
| Collector-Emitter Voltage | VCEO | 40 | v |
| Collector-Base Voltage | V _{CBO} | 60 | V |
| Emitter-Base Voltage | VEBO | 4.0 | V |
| Collector Current — Continuous | lc | 0.4 | Α |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | ాం |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|---------------|
| •Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | Raja | 125 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 12 x 0.6 mm.

MXR5160

CASE 345-01, STYLE 1 SOT-89

RF TRANSISTOR

PNP SILICON

| Characteristic | Symbol | Min | Max | Unit |
|---|-----------|-----|-----|-------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Sustaining Voltage (IC = 5.0 mA) | VCEO(sus) | 40 | _ | \ \ \ |
| Emitter-Base Breakdown Voltage (I _E = 0.1 mA) | V(BR)EBO | 4.0 | _ | V |
| Collector Cutoff Current (VCB = 28 V) | Ісво | | 1.0 | μΑ |
| Collector Cutoff Current (VCE = 60 V) | ICES | | 0.1 | mA |
| Emitter Cutoff Current (VCE = 28 V) | ICEO | | 20 | μΑ |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 50 mA, V _{CE} = 5.0 V) | pŁĘ | 10 | _ | _ |
| SMALL-SIGNAL CHARACTERISTICS | | | | , |
| Current-Gain — Bandwidth Product (IC = 50 mA, VCE = 15 V, f = 200 MHz) | fτ | 500 | _ | MHz |

MXR5583

CASE 345-01, STYLE 1 SOT-89

HIGH FREQUENCY RF TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|----------------------|-------------|------|
| Collector-Emitter Voltage | VCEO | 30 | ٧ |
| Collector-Base Voltage | V _{CBO} | 30 | V |
| Emitter-Base Voltage | VEBO | 3.0 | V |
| Collector Current — Continuous | Ic | 500 | mA |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | င |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|---------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | RAJA | 125 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 12 x 0.6 mm.

| Characteristic | Symbol | Min | Max | Unit |
|--|---------------------------------------|----------------|---------------|----------|
| OFF CHARACTERISTICS | · · · · · · · · · · · · · · · · · · · | | • | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mA) | V(BR)CEO | 30 | _ | ٧ |
| Collector-Base Breakdown Voltage(1) (IC = 10 µA) | V(BR)CBO | 30 | _ | ٧ |
| Emitter-Base Breakdown Voltage (I _E = 100 µA) | V(BR)EBO | 3.0 | _ | ٧ |
| Collector Cutoff Current (VCB = 20 V) | ICBO | _ | 50 | nA |
| Emitter Cutoff Current (VEB = 2.0 V) | IEBO | - | 0.5 | μА |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 40 mA, V_{CE} = 2.0 V) (I _C = 100 mA, V_{CE} = 2.0 V) (I _C = 300 mA, V_{CE} = 5.0 V) | hFE | 20 25 15 | _ 100 _ | |
| Collector-Emitter Saturation Voltage (I _C = 100 mA, I _B = 10 mA) | VCE(sat) | | 0.8 | ٧ |
| Base-Emitter On Voltage (IC = 100 mA, VCE = 2.0 V) | V _{BE(on)} | _ | 1.8 | ٧ |
| SMALL-SIGNAL CHARACTERISTICS | | | • | <u> </u> |
| Current-Gain — Bandwidth Product (IC = 40 mA, VCE = 10 V, f = 100 MHz) (IC = 100 mA, VCE = 10 V, f = 100 MHz) | fT | 1000 1300 | _ | MHz |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|------|
| Collector-Emitter Voltage | VCEO | 30 | ٧ |
| Collector-Base Voltage | V _{СВО} | 40 | V |
| Emitter-Base Voltage | V _{EBO} | 3.5 | V |
| Collector Current — Continuous | lc | 400 | mA |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|---------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | ROJA | 125 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 12 x 0.6 mm.

MXR5943

CASE 345-01, STYLE 1 SOT-89

RF TRANSISTOR

NPN SILICON

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|----------------------|----------|------|
| OFF CHARACTERISTICS | | | <u> </u> | |
| Collector-Emitter Breakdown Voltage (I _C = 5.0 mA) | V(BR)CEO | 30 | _ | V |
| Collector-Base Breakdown Voltage (I _C = 100 μA) | V(BR)CBO | 40 | - | v |
| Emitter-Base Breakdown Voltage (I _E = 100 µA) | V(BR)EBO | 3.5 | | V |
| Collector Cutoff Current (VCE = 20 V) | ICEO | _ | 50 | μΑ |
| Collector Cutoff Current (VCB = 15 V) | lCBO | | 10 | μА |
| ON CHARACTERISTICS | | | | |
| DC Current Gain ($I_C = 50 \text{ mA}$, $V_{CE} = 15 \text{ V}$) | hFE | 25 | 300 | |
| Collector-Emitter Saturation Voltage (I _C = 100 mA, I _B = 10 mA) | VCE(sat) | _ | 0.2 | ٧ |
| Base-Emitter Saturation Voltage (I _C = 100 mA, I _B = 10 mA) | V _{BE(sat)} | _ | 1.0 | ٧ |
| SMALL SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 25 mA, VCE = 15 V, f = 200 MHz) (IC = 50 mA, VCE = 15 V, f = 200 MHz) (IC = 100 mA, VCE = 15 V, f = 200 MHz) | ft | 1000 1200 1000 | = | MHz |

MXT3904

CASE 345-01, STYLE 1 SOT-89

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltge | V _{CBO} | 60 | Vdc |
| Emitter-Base Voltage | V _{EBO} | 6.0 | Vdc |
| Collector Current — Continuous | lc | 200 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|---------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | RAJA | 125 | •cw |

^{*}Package mounted on 99.5% alumina 10 x 12 x 0.6 mm.

Refer to 2N3904 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|----------------------|-----------------------------|--------------|--------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 40 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | V(BR)CBO | 60 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 6.0 | _ | Vdc |
| Base Cutoff Current (VCE = 30 Vdc, VEB = 3.0 Vdc) | IBL | - | 50 | nAdc |
| Collector Cutoff Current (VCE = 30 Vdc, VEB = 3.0 Vdc) | ICEX | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain(1) (I _C = 0.1 mAdc, V _{CE} = 1.0 Vdc) (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) (I _C = 50 mAdc, V _{CE} = 1.0 Vdc) (I _C = 100 mAdc, V _{CE} = 1.0 Vdc) | hFE | 40 70 100 60 30 | 300 | _ |
| Collector-Emitter Saturation Voltage(1) (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc) | VCE(sat) | 1.1 | 0.2 0.3 | Vdc |
| Base-Emitter Saturation Voltage(1) (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc) | V _{BE(sat)} | 0.65 | 0.85 0.95 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | 1 |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz) | fT | 300 | | MHz |
| Output Capacitance (VCB = 5.0 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | _ | 4.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | C _{ibo} | - | 8.0 | pF |
| Input Impedance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{ie} | 1.0 | 10 | k ohms |
| Voltage Feedback Ratio {I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz} | h _{re} | 0.5 | 8.0 | X 10-4 |
| Small-Signal Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | hfe | 100 | 400 | |

MXT3904

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|--|-----------------|-----|-----|-------|
| Output Admittance (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{oe} | 1.0 | 40 | μmhos |
| Noise Figure (IC = 100 μ Adc, VCE = 5.0 Vdc, RS = 1.0 k ohms, f = 10 Hz to 15.7 kHz) | NF | _ | 5.0 | dB |

SWITCHING CHARACTERISTICS

| Delay Time | (V _{CC} = 3.0 Vdc, V _{BE} = 0.5 Vdc, | td | | 35 | ns |
|--------------|--|----------------|---|-----|----|
| Rise Time | IC = 10 mAdc, IB1 = 1.0 mAdc) | t _r | _ | 35 | ns |
| Storage Time | (V _{CC} = 3.0 Vdc, I _C = 10 mAdc, I _{B1} = I _{B2} = 1.0 mAdc) | tg | _ | 200 | ns |
| Fall Time | | tf | _ | 50 | ns |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MXT3906

CASE 345-01, STYLE 1 SOT-89

GENERAL PURPOSE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | Ic | 200 | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|---------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | RøJA | 125 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 12 x 0.6 mm.

Refer to 2N3905 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|----------------------|-----------------------------|--------------|--------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (I _C = 1.0 mAdc, I _B = 0) | V(BR)CEO | 40 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 µAdc, I _E = 0) | V(BR)CBO | 40 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 5.0 | - | Vdc |
| Base Cutoff Current (VCE = 30 Vdc, VBE = 3.0 Vdc) | l _B L | _ | 50 | nAdc |
| Collector Cutoff Current (VCE = 30 Vdc, VBE = 3.0 Vdc) | ICEX | _ | 50 | nAdc |
| ON CHARACTERISTICS(1) | | | | |
| DC Current Gain (I _C = 0.1 mAdc, V _{CE} = 1.0 Vdc) (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) (I _C = 50 mAdc, V _{CE} = 1.0 Vdc) (I _C = 50 mAdc, V _{CE} = 1.0 Vdc) | hFE | 60 80 100 60 30 | | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc) | VCE(sat) | = | 0.25 0.4 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc) | V _{BE(sat)} | 0.65 — | 0.85 0.95 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 100 MHz) | fτ | 250 | _ | MHz |
| Output Capacitance (VCB = 5.0 Vdc, IE = 0, f = 100 kHz) | C _{obo} | _ | 4.5 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 100 kHz) | Cibo | - | 10.0 | pF |
| Input Impedance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{ie} | 2.0 | 12 | k ohms |
| Voltage Feedback Ratio (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{re} | 0.1 | 10 | X 10-4 |
| Small Signal Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{fe} | 100 | 400 | - |

| Characteristic | Symbol | Min | Max | Unit |
|---|-----------------|-----|-----|-------|
| Output Admittance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{oe} | 3.0 | 60 | μmhos |
| Noise Figure (I _C = 100 μ Adc, V _{CE} = 5.0 Vdc, R _S = 1.0 k ohm, f = 10 Hz to 15.7 kHz) | NF | _ | 4.0 | dB |

| SWITCHING CHARACTERISTICS |
|---------------------------|
|---------------------------|

| Delay Time | (VCC = 3.0 Vdc, VBE = 0.5 Vdc | td | _ | 35 | ns |
|--------------|-------------------------------|----------------|---|-----|----|
| Rise Time | IC = 10 mAdc, IB1 = 1.0 mAdc) | t _r | - | 35 | ns |
| Storage Time | (VCC = 3.0 Vdc, IC = 10 mAdc, | ts | _ | 225 | ns |
| Fail Time | IB1 = IB2 = 1.0 mAdc) | tf | | 75 | ns |

⁽¹⁾ Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

MXTA14

CASE 345-01, STYLE 1 SOT-89

DARLINGTON TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|------------------|-------|------|
| Collector-Emitter Voltage | V _{CEO} | 30 | V |
| Collector-Emitter Voltage | VCES | 30 | v |
| Emitter-Base Voltage | VEBO | 10 | ٧ |
| Collector Current — Continuous | lc | 300 | mV |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|---------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Storage Temperature | T _{stg} | 150 | |
| *Thermal Resistance Junction to Ambient | ReJA | 125 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 12 x 0.6 mm.

Refer to 2N6426 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|----------------------|--------------|-----|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 100 µA) | V(BR)CES | 30 | _ | |
| Collector Cutoff Current (VCB = 30) | ІСВО | _ | 100 | nA |
| Emitter Cutoff Current (VBE = 10 V) | lEBO | _ | 100 | nA |
| ON CHARACTERISTICS | | | | |
| DC Current Gain(1) (IC = 10 mA, V_{CE} = 5.0 V) (IC = 100 mA, V_{CE} = 5.0 V) | µŁE | 10 K 20 K | = | - |
| Collector-Emitter Saturation Voltage(1) (IC = 100 mA, Ig = 0.1 mA) | V _{CE(sat)} | _ | 1.5 | ٧ |
| Base-Emitter On Voltage (IC = 100 mA, VCE = 5.0 V) | VBE(on) | - | 2.0 | ٧ |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (VCE = 5.0 V, IC = 10 mA, f = 100 MHz) | fΤ | 125 | _ | MHz |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0 %.

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|--------|-------|------|
| Collector-Emitter Voltage | VCES | 60 | ٧ |
| Emitter-Base Voltage | VEBO | 10 | ٧ |
| Collector Current — Continuous | Ic | 500 | mA |

THERMAL CHARACTERISTICS

| IIIEIMAE OIDAMOIEIMOITO | | | |
|---|------------------|------------|---------------|
| Characteristic | Symbol | Max | Unit |
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | RAJA | 125 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 12 x 0.6 mm.

MXTA27

CASE 345-01, STYLE 1 SOT-89

DARLINGTON TRANSISTOR

NPN SILICON

Refer to MPSA25 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|---------------------|--------------|-----|------|
| OFF CHARACTERISTICS | • | | | |
| Collector-Emitter Breakdown Voltage (I _C = 100 μA) | V(BR)CES | 60 | _ | ٧ |
| Collector-Base Breakdown Voltage (I _C = 100 μA) | V(BR)CBO | 60 | _ | ٧ |
| Collector Cutoff Current (VCB = 50 V) | ІСВО | | 100 | nA |
| Collector Cutoff Current (VCE = 50 V) | ICES | ı | 500 | nA |
| Emitter Cutoff Current (VBE = 10 V) | IEBO | ı | 100 | пA |
| ON CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 100 mA, IB = 0.1 A) | VCES | 1 | 1.5 | V |
| Base-Emitter On Voltage (I _C = 100 mA, V _{CE} = 5.0 V) | V _{BE(on)} | 1 | 2.0 | ٧ |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mA, VCE = 5.0 V) (IC = 100 mA, VCE = 5.0 V) | ţţ | 10 K 10 K | = | _ |
| Current Gain — High Frequency (IC = 10 mA, VCE = 5.0 V, f = 100 MHz) | h _{fe} | 1.25 | - | _ |

MXTA42 MXTA43

CASE 345-01, STYLE 1 SOT-89

HIGH VOLTAGE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | MPSA42 | MPSA43 | Unit |
|--------------------------------|--------|--------|--------|------|
| Collector-Emitter Voltage | VCEO | 300 | 200 | Vdc |
| Collector-Base Voltage | VCBO | 300 | 200 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | 6.0 | Vdc |
| Collector Current — Continuous | lc | 500 | | mAdc |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|--------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/℃ |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | ReJA | 125 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 12 x 0.6 mm.

Refer to MPSA42 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------------|----------------------|------------|------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, Ig = 0) | MXTA42 MXTA43 | V(BR)CEO | 300 200 | = | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μAdc, IE = 0) | MXTA42 MXTA43 | V(BR)CBO | 300 200 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 µAdc, IC = 0) | | V(BR)EBO | 6.0 | _ = | Vdc |
| Collector Cutoff Current (VCB = 200 Vdc, IE = 0) (VCB = 160 Vdc, IE = 0) | MXTA42 MXTA43 | ICBO | | 0.1 0.1 | μAdc |
| Emitter Cutoff Current (VBE = 6.0 Vdc, IC = 0) (VBE = 4.0 Vdc, IC = 0) | MXTA42 MXTA43 | [†] EBO | = | 0.1 0.1 | μAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc) (IC = 10 mAdc, VCE = 10 Vdc) | Both Types Both Types | pEE | 25 40 | = | |
| (IC = 30 mAdc, V _{CE} = 10 Vdc) | MXTA42 MXTA43 | | 40 40 | _ | |
| Collector-Emitter Saturation Voltage (I _C = 20 mAdc, I _B = 2.0 mAdc) | MXTA42 MXTA43 | VCE(sat) | = | 0.5 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 20 mAdc, IB = 2.0 mAdc) | | V _{BE(sat)} | _ | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz) | | fΤ | 50 | | MHz |
| Collector-Base Capacitance (VCB = 20 Vdc, IE = 0, f = 1.0 MHz) | MXTA42 MXTA43 | C _{cb} | _ | 3.0 4.0 | pF |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|--------|-------|------|
| Collector-Emitter Voltage | VCEO | 400 | V |
| Collector-Base Voltage | VCBO | 500 | V |
| Emitter-Base Voltage | VEBO | 6.0 | V |
| Collector Current — Continuous | ic ic | 300 | mA |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|---------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | ReJA | 125 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 12 x 0.6 mm.

MXTA44

CASE 345-01, STYLE 1 SOT-89

HIGH VOLTAGE TRANSISTOR

NPN SILICON

Refer to MPSA44 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|------------------|----------------------|--------------------|------|
| OFF CHARACTERISTICS | | | | : |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mA, IB = 0) | V(BR)CEO | 400 | _ | ٧. |
| Collector-Emitter Breakdown Voltage (I _C = 100 μA, V _{BE} = 0) | V(BR)CES | 500 | - | ٧ |
| Collector-Base Breakdown Voltage (I _C = 100 μA, I _B = 0) | V(BR)CBO | 500 | _ | ٧ |
| Emitter-Base Breakdown Voltage (I _E = 10 µA, I _C = 0) | V(BR)EBO | 6.0 | - | . v |
| ON CHARACTERISTICS | | | | |
| DC Current Gain(1) (I _C = 1.0 mA, V _{CE} = 10) (I _C = 10 mA, V _{CE} = 10) (I _C = 50 mA, V _{CE} = 10) (I _C = 100 mA, V _{CE} = 10) | hfE | 40 50 45 40 | | - |
| Collector-Emitter Saturation Voltage(1) (I _C = 1.0 mA, I _B = 0.1 mA) (I _C = 10 mA, I _B = 1.0 mA) (I _C = 50 mA, I _B = 5.0 mA) | VCE(sat) | | 0.4 0.5 0.75 | ٧ |
| Base-Emitter Saturation Voltage (I _C = 10 mA, I _B = 1.0 mA) | VBE(sat) | _ | 0.75 | v |
| SMALL-SIGNAL CHARACTERISTICS | | | | * |
| Output Capacitance (V _{CB} = 20 V, I _E = 0, f = 1.0 MHz) | C _{obo} | _ | 6.0 | pF |
| Input Capacitance (VEB = 0.5 V, I _C = 0, f = 1.0 MHz) | C _{ibo} | _ | 110 | pF |
| Current Gain — High Frequency (I _C = 10 mA, V _{CE} = 10 V, f = 10 MHz) | h _{fe} | 2.0 | _ | _ |

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0 %.

MXTA64

CASE 345-01, STYLE 1 SOT-89

DARLINGTON TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|--------|-------|------|
| Collector-Emitter Voltage | VCES | 30 | Vdc |
| Collector-Base Voltage | VCBO | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 10 | Vdc |
| Collector Current — Continuous | lc | 300 | mA |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|---------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 125 | •c/w |

^{*}Package mounted on 99.5% alumina 10 x 12 x 0.6 mm.

| Characteristic | Symbol | Min | Max | Unit |
|--|---------------------|----------------|-----|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 100 µA) | V(BR)CES | 30 | | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc) | ICBO | | 100 | nA |
| Emitter Cutoff Current (VBE = 10 Vdc) | ¹ EBO | _ | 100 | nAc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 10 mA, V _{CE} = 5.0 Vdc)(1) (IC = 100 mA, V _{CE} = 5.0 Vdc)(1) | pŁE | 10000 20000 | | _ |
| Collector-Emitter Saturation Voltage (IC = 100 mA, Ig = 0.1 mA)(1) | VCE(sat) | _ | 1.5 | Vdc |
| Base-Emitter On Voltage (IC = 100 mA, VCE = 5.0 Vdc)(1) | V _{BE(on)} | _ | 2.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (VCF = 5.0 Vdc, IC = 100 mA, f = 100 MHz) | fΤ | 125 | _ | MHz |

⁽¹⁾ Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--------------------------------|--------|-------|------|
| Collector-Emitter Voltage | VCES | 60 | V |
| Emitter-Base Voltage | VEBO | 10 | V |
| Collector Current — Continuous | lc lc | 300 | mA |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------------|---------------|
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | RAJA | 125 | °C/W |

^{*}Package mounted on 99.5% alumina 10 x 12 x 0.6 mm.

MXTA77

CASE 345-01, STYLE 1 SOT-89

DARLINGTON TRANSISTOR

PNP SILICON

Refer to MPSA75 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|---------------------|--------------|-----|------|
| OFF CHARACTERISTICS | | | · | |
| Collector-Emitter Breakdown Voltage (IC = 100 µA) | V(BR)CES | 60 | _ | ٧ |
| Collector-Base Breakdown Voltage (IC = 100 µA) | V(BR)CBO | 60 | _ | ٧ |
| Collector Cutoff Current (VCB = 50 V) | СВО | - | 100 | nA |
| Collector Cutoff Current (VCE = 50 V) | ICES | - | 500 | nA |
| Emitter Cutoff Current (VBE = 10 V) | lEBO | - | 100 | nA |
| ON CHARACTERISTICS | | | I— | |
| DC Current Gain (IC = 10 mA, V _{CE} = 5.0 V) (IC = 100 mA, V _{CE} = 5.0 V) | phE | 10 K 10 K | _ | _ |
| Collector-Emitter Saturation Voltage (I _C = 100 mA, I _B = 0.1 mA) | VCE(sat) | _ | 1.5 | ٧ |
| Base-Emitter On Voltage (IC = 100 mA, VCE = 5.0 V) | V _{BE(on)} | _ | 2.0 | V |
| Current Gain — High Frequency (IC = 10 mA, VCE = 5.0 V, f = 100 MHz) | h _{fe} | 1.25 | _ | _ |

MXTA92 MXTA93

CASE 345-01, STYLE 1 SOT-89

HIGH VOLTAGE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | MPS-A92 | MPS-A93 | Unit |
|--------------------------------|------------------|---------|---------|------|
| Collector-Emitter Voltage | VCEO | 300 | 200 | Vdc |
| Collector-Base Voltage | V _{CBO} | 300 | 200 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc |
| Collector Current — Continuous | lc | 500 | | mAdc |

THERMAL CHARACTERISTICS

| THE HALL OF A LACTE HIS 1100 | | | |
|---|------------------|------------|---------------|
| Characteristic | Symbol | Max | Unit |
| *Total Device Dissipation, T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | Watt mW/°C |
| Storage Temperature | T _{stg} | 150 | °C |
| *Thermal Resistance Junction to Ambient | R _{ØJA} | 125 | °C/W |

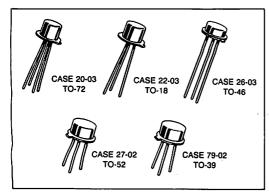
^{*}Package mounted on 99.5% alumina 10 x 12 x 0.6 mm.

Refer to MPSA92 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------------|----------------------|------------|--------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (I _C = 1.0 mAdc, I _B = 0) | MXTA92 MXTA93 | V(BR)CEO | 300 200 | | Vdc |
| Collector-Base Breakdown Voltage ($I_C = 100 \mu Adc$, $I_E = 0$) | MXTA92 MXTA93 | V(BR)CBO | 300 200 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 200 Vdc, IE = 0) (VCB = 160 Vdc, IE = 0) | MXTA92 MXTA93 | ICBO | = | 0.25 0.25 | μAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | | 1EBO | _ | 0.1 | μAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc) | Both Types Both Types | hFE | 25 40 | _ | - |
| ($I_C = 30 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$) | MXTA92 MXTA93 | | 25 25 | 150 | |
| Collector-Emitter Saturation Voltage (I _C = 20 mAdc, I _B = 2.0 mAdc) | MXTA92 MXTA93 | VCE(sat) | = | 0.5 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 20 mAdc, Ig = 2.0 mAdc) | | V _{BE(sat)} | _ | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, V _{CE} = 20 Vdc, f = 100 MHz) | | fτ | 50 | | MHz |
| Collector-Base Capacitance (VCB = 20 Vdc, I _E = 0, f = 1.0 MHz) | MXTA92 MXTA93 | C _{cb} | _ | 6.0 8.0 | pF |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.



Motorola's metal-can transistor product offering includes: general purpose, switching, high voltage, choppers, Darlingtons, low noise amplifiers and RF amplifiers.

A variety of package options are available: TO-18, TO-46, TO-52, TO-72, and TO-39.

Many devices contained in this section are also available with high reliability MIL-S-19500 processing. JAN, JANTX, JANTXV, and JANS qualified devices are so noted on the following data sheets.

Metal Transistors

2N656 2N657

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MAXIMOM PATINGS | | | | | |
|---|-----------------------------------|-------|------------|----------------|---|
| Rating | Symbol | 2N656 | 2N657 | Unit | l |
| Collector-Emitter Voltage | VCEO | 60 | 100 | Vdc | |
| Collector-Base Voltage | VCBO | 60 | 100 | Vdc | |
| Emitter-Base Voltage | VEBO | 8 | .0 | Vdc | |
| Collector Current — Continuous 2N656 2N657 | ĺĊ | | .0).5 | Adc | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1 ' | .0 .7 | Watt mW/℃ | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | | l.0 2.8 | Watts mW/°C | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 t | o +200 | °C | |

Refer to 2N3498 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|----------------|-----------------|-----------|-----|-------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 250 μ Adc, IB = 0) | 2N656 2N657 | V(BR)CEO | 60 100 | = | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μ Adc, IE = 0) | 2N656 2N657 | V(BR)CBO | 60 100 | = | Vdc |
| Emitter-Base Breakdown Voltage (IE = 250 µAdc, IC = 0) | | V(BR)EBO | 8.0 | - | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0) | | ICBO | _ | 10 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 200 mAdc, V _{CE} = 10 Vdc) | | ptE | 30 | 90 | _ |
| Collector-Emitter Saturation Voltage(1) (IC = 200 mAdc, Ig = 40 mAdc) | | VCE(sat) | _ | 4.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Input Impedance(1) (IR = 8.0 mAdc, VCE = 10 Vdc) | | h _{ie} | _ | 0.5 | k ohm |

⁽¹⁾ Pulse Test: Pulse Length = 300 µs, Duty Cycle ≤ 2.0%.

CASE 79, STYLE 1 TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS Rating Symbol Value Unit Collector-Emitter Voltage VCER 40 Vdc Collector-Base Voltage **VCBO** Vdc **Emitter-Base Voltage** VEBO Vdc 5.0 Total Device Dissipation @ TA = 25°C PD 0.6 Watt Derate above 25°C 4.0 mW/°C Total Device Dissipation @ T_C = 25°C PD 2.0 Watts Derate above 25°C 13.3 mW/°C Operating and Storage Junction Tj, Tstg

Refer to 2N2218 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

Temperature Range

| Symbol | Min | May | Unit |
|----------------------|---|--|---------------|
| | ****** | IVIAX | Unit |
| V(BR)CER | 40 | - | Vdc |
| V(BR)CBO | 60 | | Vdc |
| V(BR)EBO | 5.0 | | Vdc |
| lСВО | | 1.0 | μAdc |
| | | | |
| hFE | 40 | 120 | _ |
| VCE(sat) | _ | 1.5 | Vdc |
| V _{BE(sat)} | _ | 1.3 | Vdc |
| <u></u> - | | | |
| C _{obo} | -] | 35 | pF |
| hfe | 2.5 | | MHz |
| | V(BR)CBO V(BR)EBO ICBO hFE VCE(sat) VBE(sat) | V(BR)CER 40 V(BR)CBO 60 V(BR)EBO 5.0 ICBO hFE 40 VCE(sat) VBE(sat) | V(BR)CER 40 |

-65 to +200

°C

⁽¹⁾ Pulse Test: Pulse Length ≤ 12 ms, Duty Cycle ≤ 2.0%.

CASE 79, STYLE 1 TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCER | 80 | Vdc |
| Collector-Base Voltage | V _{CBO} | 120 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.6 4.0 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.0 13.3 | Watts mW/°C |
| Operating and Storage Temperature Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

THERMAL CHARACTERISTICS

| I HERIVIAL CHARACTERISTICS | | | |
|---|--------|-----|------|
| Characteristic | Symbol | Max | Unit |
| Thermal Resistance, Junction to Case | RAJC | 75 | °C/W |
| Thermal Resistance, Junction to Ambient | | 250 | °C/W |

Refer to 2N3019 for graphs.

| ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.) Characteristic | Symbol | Min | Max | Unit |
|--|-----------------|----------|------------|---------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (1) (IC = 100 mAdc, RBE ≦ 10 ohms) | V(BR)CER | 80 | | Vdc |
| (IC = 100 IMAC, TIGE = 10 0 IM | ІСВО | | 2.0 200 | μAdc |
| Emitter Cutoff Current (VEB = 2.0 Vdc, I _C = 0) | !EBO | | 100 | μAdc |
| ON CHARACTERISTICS | | 40 | 120 | |
| DC Current Gain (1) (IC = 150 mAdc, VCE = 10 Vdc) | pŁE | 40 | | Vdc |
| Collector-Emitter Saturation Voltage (1) (IC = 150 mAdc, Ig = 15 mAdc) | VCE(sat) | | 5.0 | |
| Base-Emitter Saturation Voltage (1) (IC = 150 mAdc, IB = 15 mAdc) | VBE(sat) | - | 1.3 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | MHz |
| Current-Gain — Bandwidth Product (I _C = 50 mAdc, V _{CE} = 10 Vdc, f = 20 MHz) | ft | 50 | 20 | pF |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | Cobo | | 20 | <u></u> |
| Input Impedance (Ic = 1.0 mAdc, VcR = 5.0 Vdc, f = 1.0 kHz) | hib | 20 — | 30 10 | Ohms |
| Voltage Feedback Ratio (Ic = 1.0 mAdc, VcB = 10 Vdc, 1 = 1.0 kHz) | h _{rb} | _ | 2.5 3.0 | X 10-4 |
| (IC = 5.0 mAde, VCB = 10 Vdc, f = 1.0 kHz) Small Signal Current Gain (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | h _{fe} | 35 45 | 100 | _ |
| (I _C = 5.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) Output Admittance (I _C = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) (I _C = 5.0 mAdc, V _{CB} = 10 Vdc, f = 1.0 kHz) | h _{ob} | 0.05 | 0.5 1.0 | μmhos |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

JAN AVAILABLE CASE 22, STYLE 1 TO-18 (TO-206AA)

SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|-------------|
| Collector-Emitter Voltage | VCEO | 25 | Vdc |
| Collector-Base Voltage | V _{CBO} | 25 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 2.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 600 4.0 | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +175 | °C |

Refer to 2N2368 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|---------------------|----------|-------------|-----------|----------|
| OFF CHARACTERISTICS | | | | L | <u> </u> |
| Collector-Emitter Breakdown Voltage (I _C = 2.0 mAdc, I _B = 0) | V(BR)CEO | 25 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 5.0 µAdc, I _E = 0) | V(BR)CBO | 25 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCE = 20 Vdc, IB = 0) | ICEO | _ | _ | 10 | μAdc |
| Collector Cutoff Current (V _{CB} = 10 Vdc, I _E = 0) (V _{CB} = 10 Vdc, I _E = 0, T _A = +150°C) | ICBO | - 1 | _ | 0.5 50 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(1) (IC = 10 mAdc, V _{CE} = 5.0 Vdc) (IC = 10 mAdc, V _{CE} = 5.0 Vdc, T _A = -55°C) | hFE | 40 20 | _ | 100 | _ |
| Collector-Emitter Saturation Voltage(1) (IC = 10 mAdc, IB = 0.5 mAdc) | VCE(sat) | - | _ | 0.5 | Vdc |
| Bese-Emitter On Voltage(1) (IC = 10 mAdc, VCE = 5.0 Vdc) | V _{BE(òn)} | 0.7 | - | 0.95 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | <u> </u> | |
| Current-Gain — Bandwidth Product (Ig = 10 mAdc, V _{CE} = 5.0 Vdc, f = 100 MHz) | fτ | 70 | 150 | _ | MHz |
| Output Capacitance (VCB = 5.0 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | _ | 3.0 | 6.0 | pF |

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle = 2.0%

2N706,A,B

(2N706 JAN AVAILABLE) CASE 22, STYLE 1 TO-18 (TO-206AA)

SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MIANIMON NATINGS | | | | |
|--|---------------------------|----------------------|-------------------|----------------|
| Rating | | Symbol | Value | Unit |
| Collector-Emitter Voltage | 2N706A,B | VCEO | 15 | Vdc |
| Collector-Emitter Voltage | (1) | VCER | 20 | Volts |
| Collector-Base Voltage | | VCBO | 25 | Volts |
| Emitter-Base Voltage | 2N706 2N706A 2N706B | VEBO | 3.0 5.0 5.0 | Volts |
| Collector Current | 2N706,A,B | l _C | 50 | mA |
| Total Device Dissipation (Derate above 25°C | @ T _A = 25℃ | PD | 0.3 2.0 | Watt mW/℃ |
| Total Device Dissipation (Derate above 25°C | @ T _C = 25℃ | PD | 1.0 6.67 | Watts mW/°C |
| Total Device Dissipation (Derate above 100°C | @ T _C = 100°C | PD | 0.5 | Watt |
| Operating and Storage Ju Temperature Range | inction | Tj, T _{stg} | -65 to +200 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|-----|------|
| Thermal Resistance, Junction to Case | ReJC | 150 | •c/w |
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 500 | •c/w |

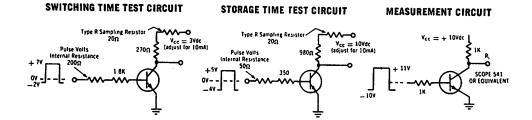
Refer to 2N2368 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|------------------------------|------------------|--------------|-----------------|------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (I _C = 10 mAdc, I _B = 0) | | V(BR)CEO | 15 | _ | Vdc |
| Collector-Emitter Breakdown Voltage(2) (R = 10 ohms, IC = 10 mAdc) | | V(BR)CER | 20 | _ | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, !E = 0) (VCB = 15 Vdc, !E = 0, TA = 150°C) (VCB = 25 Vdc, !E = 0) | 2N706A, 2N706B | Ісво | = | 0.5 30 10 | μAdc |
| Collector Cutoff Current (VCE = 20 Vdc, RBE = 100k) | 2N706A, 2N706B | ICER | | 10 | μAdc |
| Emitter Cutoff Current (VEB = 3.0 Vdc, IC = 0) (VEB = 5.0 Vdc, IC = 0) | 2N706 2N706A, 2N706B | IEBO | - | 10 10 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(2) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) | 2N706 2N706A, 2N706B | hFE | 20 20 | _ 60 | - . |
| Collector-Emitter Saturation Voltage(2) (IC = 10 mAdc, Ig = 1.0 mAdc) | 2N706, 2N706A 2N706B | VCE(sat) | = | 0.6 0.4 | Vdc |
| Base-Emitter Saturation Voltage(2) (IC = 10 mAdc, Ig = 1.0 mAdc) | 2N706 2N706A, 2N706B | VBE(sat) | 0.7 | 0.9 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | <u> </u> | т |
| Current-Gain — Bandwidth Product (VCE = 15 Vdc, IE = 10 mAdc, f = 100 MHz) | | fτ | 200 | | MHz |
| Output Capacitance (VCB = 5.0 Vdc, IE = 0) (VCB = 10 Vdc, IE = 0) | 2N706A, 2N706B 2N706 | C _{obo} | | 5.0 6.0 | pF |
| Magnitude of Forward Current Transfer Ratio, Common-I (VCE = 15 Vdc, IE = 10 mAdc, f = 100 Mhz) (VCE = 10 Vdc, IE = 10 mAdc, f = 100 MHz) | Emitter 2N706 2N706A,B | h _{fe} | 2.0 2.0 | = | - |

2N706,A,B

| Characteristic | | Symbol | Min | Max | Unit |
|---|-------------------------------------|--------|-----|----------|------|
| Collector Base Time Constant (VCE = 15 Vdc, IE = 10 mAdc, f = 300 MHz) | | rb | | 50 | ohms |
| Storage Time | 2N706B | ts | _ | 25 | ns |
| Turn-On Time (l _{B1} = 3.0 mA, l _{B2} = 1.0 mA) | | ton | _ | 40 | ns |
| Turn-Off Time (I _{B1} = 3.0 mA, I _{B2} = 1.0 mA) | · · · · · · · · · · · · · · · · · · | toff | _ | 75 | ns |
| Charge Storage Time Constant(2) | 2N706 2N706A,B | τs | | 60 25 | ns |

- (1) Refers to collector breakdown voltage in the high current region when R_{be} = 10 Ω (2) Pulse Test: Pulse Width \leq 12 μ s, Duty Cycle \leq 2.0%.
- (3) Switching Times Measured with Tektronix Type R Plug-In (50 Ω Internal Impedance).



JAN, JTX AVAILABLE CASE 22, STYLE 1 TO-18 (TO-206AA)

SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| IVIAAIIVIUIVI RATIIVGS | | | |
|--|-----------------------------------|--------------------------|-------------------------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 15 | Vdc |
| Collector-Emitter Voltage | VCER | 20 | Vdc |
| Collector-Base Voltage | VCBO | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | IC | limited by | P _D only |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 360 2.1 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C T _C = 100°C Derate above 25°C Derate above 100°C | PD | 1.2 680 6.9 6.9 | Watts mW mW/°C mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|--------------------------------------|--------|-----|------|
| Thermal Resistance, Junction to Case | ReJC | 145 | °C/W |

Refer to 2N2368 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|-----------------------|----------------|--------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 30 mAdc, R _{BE} ≤ 10 ohms) | V _{CER(sus)} | 20 | _ | Vdc |
| Collector-Emitter Sustaining Voltage (I _C = 30 mAdc, I _B = 0) | V _{CEO(sus)} | 15 | - | Vdc |
| Collector-Base Breakdown Voltage (I _C = 1.0 μAdc, I _E = 0) | V(BR)CBO | 40 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 20 Vdc, VBE = 0.25 Vdc, TA = +125°C) | ICEX | | 10 | μAdc |
| Collector Cutoff Current (V _{CB} = 20 Vdc, I _E = 0) (V _{CB} = 20 Vdc, I _C = 0, T _A = 150°C) | СВО | _ | 0.025 15 | μAdc |
| Emitter Cutoff Current (VBE = 4.0 Vdc, IC = 0) | I _{EBO} | | 0.08 | μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 0.5 mAdc, V _{CE} = 1.0 Vdc) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc)(1) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc, T _A = -55°C)(1) | PEE | 15 30 15 | 120 — | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 7.0 mAdc, I _B = 0.7 mAdc, T _A = -55°C to +125°C) | VCE(sat) | _ = | 0.4 0.4 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 7.0 mAdc, I _B = 0.7 mAdc, T _A = -55°C) | V _{BE(sat)} | 0.72 — | 0.80 0.90 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAde, VCE = 10 Vdc, f = 100 MHz) | fΤ | 300 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, 100 kHz ≤ f ≤ 1.0 MHz) | C _{obo} | _ | 6.0 | pF |
| Extrinsic Base Resistance (IC = 10 mAdc, VCE = 10 Vdc, f = 300 MHz) | ιP, | 1 | 50 | ohms |
| SWITCHING CHARACTERISTICS | | | | |
| Storage Time (I _C = I _{B1} = I _{B2} = 10 mAdc) | t _s | _ | 25 | ns |
| Turn-On Time | ton | | 40 | ns |
| Turn-Off Time | toff | - | 70 | ns |

MAXIMUM RATINGS

| INIMAIIVINI TATINGS | | | |
|---|----------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage(1) | VCER | 40 | Vdc |
| Collector-Base Voltage | V _{СВО} | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc lc | 500 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.4 2.66 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.5 10 | Watts mW/°C |
| Total Device Dissipation @T _C = 100°C | PD | 0.75 | Watt |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +175 | °C |

2N718

CASE 22, STYLE 1 TO-18 (TO-206AA)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to 2N2218 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|--|------------------|-----|------------|----------|
| OFF CHARACTERISTICS | | | * | |
| Collector-Emitter Breakdown Voltage (IC = 100 mAdc, pulsed; Rg ≤ 10 Ohms) | VCER(sus) | 40 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 60 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 1.0 mA, I _C = 0) | V(BR)EBO | 5 | | Vdc |
| Collector Cutoff Current (V _{CB} = 30 Vdc, I _E = 0) (V _{CB} = 30 Vdc, I _E = 0, T _A = 150°C) | ІСВО | _ | 1.0 100 | μAdc |
| ON CHARACTERISTICS | | | | <u> </u> |
| DC Current Gain (IC = 150 mAdc, VCE = 10 Vdc) | hFE | 40 | 120 | - |
| Collector-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) | VCE(sat) | _ | 1.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) | VBE(sat) | _ | 1.3 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | * | <u></u> |
| Output Capacitance (VCB = 10 Vdc, f = 100 kHz, l _E = 0) | C _{obo} | _ | 35 | pF |
| Input Capacitance (VBE = 0.5 V, f = 100 kHz, IC = 0) | C _{ibo} | - | 80 | pF |
| Small-Signal Current Gain (IC = 50 mAde, VCE = 10 Vdc, f = 20 MHz) | h _{fe} | 2.5 | - | _ |

(1) Pulse Test: PW ≤ 300 µs, Duty Cycle ≤ 2.0%.

2N718A 2N956, 2N1711

2N718A JAN, JTX, JTXV AVAILABLE CASE 22, STYLE 1 TO-18 (TO-206AA)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| WAXIMON RATINGS | | | | |
|---|------------------|-----------------|--------------|----------------|
| Rating | Symbol | 2N718A 2N956 | 2N1711 | Unit |
| Collector-Emitter Voltage | VCER | 9 | iO | Vdc |
| Collector-Base Voltage | V _{CBO} | 7 | 5 | Vdc |
| Emitter-Base Voltage | VEBO | 7 | .0 | Vdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 500 2.86 | 800 4.57 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.8 10.3 | 3.0 17.15 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, Tstg | -65 to | + 200 | °C |

2N718A: See 2N3019 for graphs.*

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|--------------------------|------------------|-----------|------------|----------------|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 100 mAdc, pulsed; RgE ≤ 10 ohms) | | VCER(sus) | 50 | | 1 | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | | V(BR)CBO | 75 | _ | 1 | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 7.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 60 Vdc, I _E = 0) (VCB = 60 Vdc, I _E = 0, T _A = 150°C) | · | СВО | | 0.001 — | 0.01 10 | μAdc |
| Emitter Cutoff Current (VBE = 5.0 Vdc, I _C = 0) | 2N718A, 2N956, 2N1711 | ^I EBO | _ | _ | 0.010 0.005 | μAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain (I _C = 0.01 mAdc, V _{CE} = 10 Vdc) | 2N956, 2N1711 | hFE | 20 | _ | _ | _ |
| (IC = 0.1 mAdc, V_{CE} = 10 Vdc) | 2N718A, 2N956, 2N1711 | | 20 35 | = | _ | |
| (IC = 10 mAdc, V_{CE} = 10 Vdc) | 2N718A, 2N956, 2N1711 | | 35 75 | = | = | |
| $(I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, T_A = -55^{\circ}C)$ | 2N718A, 2N956, 2N1711 | | 20 35 | = | = | |
| (IC = 150 mAdc, VCE = 10 Vdc) | 2N718A, 2N956, 2N1711 | | 40 100 | = | 120 300 | |
| (IC = 500 mAdc, VCE = 10 Vdc) | 2N718A, 2N956, 2N1711 | | 20 40 | | | |
| Collector-Emitter Saturation Voltage(1) (IC = 150 mAdc, IB = 15 mAdc) | | VCE(sat) | _ | 0.24 | 1.5 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 150 mAdc, IB = 15 mAdc) | | VBE(sat) | _ | 1.0 | 1.3 | Vdc |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

^{*2}N956 and 2N1711: See 2N3019 for graphs.

2N718A, 2N956, 2N1711

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|--------------------------|------------------|--------------|------------|------------|--------|
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 10 Vdc, f = 20 MHz) | 2N718A, 2N956, 2N1711 | fT | 60 70 | 300 300 | 1 | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | | C _{obo} | _ | 4.0 | 25 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 100 kHz) | | C _{ibo} | _ | 20 | 80 | pF |
| Input Impedance (IC = 1.0 mAdc, VCB = 5.0 Vdc, f = 1.0 kHz) (IC = 5.0 mAdc, VCB = 10 Vdc, f = 1.0 kHz) | | hib | 24 4.0 | 11 | 34 8.0 | ohms |
| Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) | 2N718A, 2N956, 2N1711 | h _{rb} | - | = | 3.0 5.0 | X 10-4 |
| (I _C = 5.0 mAdc, V _{CB} = 10 Vdc, f = 1.0 kHz) | 2N718A, 2N956, 2N1711 | | = | = | 3.0 5.0 | |
| Small-Signal Current Gain (IC = 1.0 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 kHz) | 2N718A, 2N956, 2N1711 | h _{fe} | 30 50 | = | 100 200 | _ |
| (I _C = 5.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | 2N718A, 2N956, 2N1711 | | 35 70 | = | 150 300 | |
| Output Admittance (IC = 1.0 mAdc, VCB = 5.0 Vdc, f = 1.0 kHz) (IC = 5.0 mAdc, VCB = 10 Vdc, f = 1.0 kHz) | | h _{ob} | 0.05 0.05 | | 0.5 0.5 | μmhos |
| Noise Figure (IC = 300 µAdc, VCE = 10 Vdc, f = 1.0 kHz) | 2N718A, 2N956, 2N1711 | NF | = | = | 12 8,0 | dB |

2N720A

CASE 22, STYLE 1 TO-18 (TO-206AA)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| III//IIII/III II/IIII | | | |
|---|----------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 80 | Vdc |
| Collector-Emitter Voltage | VCER | 100 | Vdc |
| Collector-Base Voltage | VCBO | 120 | Vdc |
| Emitter-Base Voltage | VEBO | 7.0 | Vdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.5 2.86 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.8 10.3 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|--------------------------------------|--------|-----|------|
| Thermal Resistance, Junction to Case | RAIC | 97 | °C/W |

Refer to 2N3019 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|----------------------|--------------------|--------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 100 mAdc, RgE ≤ 10 ohms) | VCER(sus) | 100 | _ | Vdc |
| Collector-Emitter Sustaining Voltage(1) (I _C = 30 mAdc, I _B = 0) | VCEO(sus) | 80 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 120 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 µAdc, I _C = 0) | V(BR)EBO | 7.0 | - | Vdc |
| Collector Cutoff Current (V _{CB} = 90 Vdc, I_E = 0) (V _{CB} = 90 Vdc, I_E = 0, T _A = 150°C) | СВО | | .010 15 | μAdc |
| Emitter Cutoff Current (VBE = 5.0 Vdc, IC = 0) | IEBO | _ | .010 | μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain {IC = 0.1 mAdc, VCE = 10 Vdc} {IC = 10 mAdc, VCE = 10 Vdc)(1) {IC = 10 mAdc, VCE = 10 Vdc, TA = -55°C} (IC = 150 mAdc, VCE = 10 Vdc, TA | hFE | 20 35 20 40 | _ _ _ 120 | _ |
| Collector-Emitter Saturation Voltage(1) $\{I_C = 50 \text{ mAdc}, I_B = 5.0 \text{ mAdc}\}$ $\{I_C = 150 \text{ mAdc}, I_B = 15 \text{ mAdc}\}$ | V _{CE(sat)} | _ | 1.2 5.0 | Vdc |
| Base-Emitter Saturation Voltage(1) (I _C = 50 mAdc, I _B = 5.0 mAdc) (I _C = 150 mAdc, I _B = 15 mAdc) | V _{BE(sat)} | _ | 0.9 1.3 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (I _C = 50 mAdc, V _{CE} = 10 Vdc, f = 20 MHz) | fŢ | 50 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | Cobo | - | 15 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = 0, f = 100 kHz) | C _{ibo} | _ | 85 | ρF |
| Input Impedance (IC = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz) (IC = 5.0 mAdc, V_{CB} = 10 Vdc, f = 1.0 kHz) | hib | 20 4.0 | 30 8.0 | Ohms |
| Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) (I _C = 5.0 mAdc, V _{CB} = 10 Vdc, f = 1.0 kHz) | h _{rb} | 1 1 | 1.25 1.50 | X 10-4 |
| Small-Signal Current Gain (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 kHz) (I _C = 5.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{fe} | 30 45 | 100 — | _ |
| Output Admittance (I _C = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) (I _C = 5.0 mAdc, V _{CB} = 10 Vdc, f = 1.0 kHz) | ħob | | 0.5 0.5 | μmhos |

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

MAXIMUM RATINGS

| WAXINION RATINGS | | | |
|---|-----------------------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Emitter Voltage | VCES | 30 | Vdc |
| Collector-Base Voltage | VCBO | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous Peak | lc | 200 | mAdc |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 0.3 2.0 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 6.67 | Watts mW/°C |
| Total Device Dissipation @ T _C = 100°C Derate above 100°C | PD | 0.5 6.67 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +175 | °C |

2N834 2N835

CASE 22, STYLE 1 TO-18 (TO-206AA)

SWITCHING TRANSISTOR

NPN SILICON

Refer to 2N2368 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|-----|-------------|------|
| OFF CHARACTERISTICS | | | | • |
| Collector-Base Breakdown Voltage (IC = 100 μAdc, IE = 0) | V(BR)CBO | 40 | = | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 20 Vdc, IE = 0) (VCB = 20 Vdc, IE = 0, TA = 150°C) | ІСВО | = | 0.5 30 | μAdc |
| Collector Cutoff Current (VCE = 30 Vdc, VBE = 0) | ICES | _ | 10 | μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain(1) (IC = 10 mAdc, VCE = 1.0 Vdc) | hFE | 25 | _ | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) (IC = 50 mAdc, Ig = 5.0 mAdc) | VCE(sat) | | 0.25 0.4 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 10 mAdc, IB = 1.0 mAdc) | V _{BE(sat)} | _ | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 15 Vdc, f = 100 MHz) | fT | 350 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | _ | 4.0 | pF |
| Magnitude of Forward Current Transfer Ratio, Common-Emitter (IC = 10 mAdc, VCE = 15 Vdc, f = 100 MHz) | h _{fe} | 3.5 | _ | _ |
| SWITCHING CHARACTERISTICS | | | <u> </u> | |
| Charge-Storage Time Constant (Figure 2) (IC = 10 mAdc, I _{B1} = I _{B2} = 10 mAdc) | t _S | _ | 25 | ns |
| Turn-On Time (Figure 1) (IC = 10 mAdc, I _{B1} = 3.0 mAdc, I _{B2} = 1.0 mAdc) | t _{on} | _ | 35 | ns |
| Turn-Off Time (Figure 1) (I _C = 10 mAdc, I _{B1} = 3.0 mAdc, I _{B2} = 1.0 mAdc) | t _{off} | _ | 75 | ns |

(1) Pulse Test: Pulse Width ≤ 12 ms, Duty Cycle ≤ 2.0%.

2N869A 2N4453

JAN, JTX, JTXV AVAILABLE

CASE 22-03, STYLE 1 TO-18 (TO-206AA)

2N4453 CASE 26-03, STYLE 1 TO-46 (TO-206AB)

SWITCHING TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| WANTED IN THAT IN THE | | | | |
|---|----------------------|------------------------------------|--------|-------------------------|
| Rating | Symbol | 2N869A | 2N4453 | Unit |
| Collector-Emitter Voltage | VCEO | 18 | 18 | Vdc |
| Collector-Emitter Voltage | VCES | 2 | 5 | Vdc |
| Collector-Base Voltage | VCBO | 25* | -25 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc |
| Collector Current — Continuous | ίς | 200 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 360 2.06 | | |
| Total Device Dissipation @ T _C = 25°C TC = 100°C Derate above 25°C | PD | 1.2 2.0 0.686 1.03 6.86 11.3 | | Watts Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | 2N869A | 2N4453 | Unit |
|---|--------|--------|--------|------|
| Thermal Resistance, Junction to Case | ReJC | 146 | 97.5 | °C/W |
| Thermal Resistance, Junction to Ambient | ReJA | 486 | 585 | °C/W |

| Characteristic | | Symbol | Min | Max | Unit |
|--|--|------------------|---------------------|----------------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | 2N4453 | V(BR)CEO | 18 | _ | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 10 µAdc, VBE = 0) | 2N869A, 2N4453 | V(BR)CES | 25 | _ | Vdc |
| Collector-Emitter Sustaining Voltage(1) (IC = 10 mAdc, IB = 0) | | VCEO(sus) | 18 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | 2N869A, 2N4453 | V(BR)CBO | 25 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | | V(BR)EBO | 5.0 | | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, I _E = 0, T _A = 150°C) | 2N869A | ICBO | _ | 25 | μAdc |
| Collector Cutoff Current (VCE = 15 Vdc, VBE = 0) | | ICES | - | 10 | nAdc |
| Emitter Cutoff Current (VEB = 4.5 Vdc, I _C = 0) | 2N4453 | [†] EBO | 1 | 10 | nAdc |
| Base Current (VCE = 15 Vdc, VBE = 0) | 2N869A | IB | _ | 10 | nAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain (I _C = 10 mAdc, V _{CE} = 0.3 Vdc) (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) | 2N869A 2N869A | hFE | 30 40 | 120 | - |
| (I _C = 30 mAdc, V _{CE} = 0.5 Vdc) | 2N869A, 2N4453 | | 40 | 120 | |
| (I _C = 30 mAdc, V _{CE} = 0.5 Vdc, T _A = -55°C) (I _C = 100 mAdc, V _{CE} = 1.0 Vdc) | 2N869A, 2N4453 2N869A, 2N4453 | | 17 25 | | |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 30 mAdc, I _B = 1.5 mAdc) (I _C = 30 mAdc, I _B = 3.0 mAdc) (I _C = 100 mAdc, I _B = 10 mAdc) | 2N869A 2N4453 2N869A 2N869A, 2N4453 | VCE(sat) | _ _ _ | 0.15 0.25 0.2 0.5 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 30 mAdc, I _B = 1.5 mAdc) (I _C = 30 mAdc, I _B = 3.0 mAdc) (I _C = 100 mAdc, I _B = 10 mAdc) | 2N869A 2N4453 2N869A 2N869A, 2N4453 | VBE(sat) | 0.78 0.8 0.85 | 0.98 1.1 1.2 1.7 | Vdc |

2N869A, 2N4453

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit | |
|--|------------------|--|------------------|-----|------|-----|
| SMALL-SIGNAL CHARAC | CTERISTICS | | | | | |
| Current-Gain — Bandwid | | Hz) | ft | 400 | _ | MHz |
| Output Capacitance (VCB = 5.0 Vdc, IE = 6 | D, f = 140 kHz) | 2N869A | C _{obo} | _ | 6.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = 0 | 0, f = 150 kHz) | 2N869A | C _{ibo} | _ | 6.0 | pF |
| Collector-Base Capacitan (VCB = 5.0 Vdc, IE = 0 | | 2N4453 | C _{cb} | _ | 6.0 | pF |
| Emitter-Base Capacitance (VBE = 0.5 Vdc, IC = 0 | | 2N4453 | Ceb | _ | 6.0 | pF |
| SWITCHING CHARACTE | RISTICS | | | | | |
| Turn-On Time | | V _{CC} = 2.0 Vdc, 2N869A | ton | _ | 50 | ns |
| Delay Time | lc = 30 mAdc, | | td | _ | 35 | ns |
| Rise Time | 181 - 1.5 IIIAde | 2114400 | t _r | _ | 20 | ns |
| Turn-Off Time | IC = 30 mAdc, | V _{CC} = 2.0 Vdc 2N869A | toff | | 80 | ns |
| Storage Time | IB1 = IB2 = | V _{CC} = 3.0 Vdc 2N4453 2N4453 | t _S | - | 65 | ns |
| Fall Time | | 2111-33 | tf | _ | 20 | ns |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle = 1.0%.

TYPICAL SWITCHING CHARACTERISTICS

FIGURE 1 - SWITCHING TEST CIRCUIT VALUES

| | | V _{in} Volts | V _{BB} Volts | V _{CC} Volts | R _L Ohms | IC mA | I _{B1} ⁽⁴⁾ mA | 1B2 ⁽⁴⁾ mA |
|--------------|--------|--------------------------|--------------------------|--------------------------|------------------------|----------|--------------------------------------|--------------------------|
| ton, tr, td | 2NB69A | -7.0 | 3.0 | 2.0 | 62 | 30 | 1.5 | _ |
| | 2N4453 | -7.0 | 3.0 | 3.0 | 91 | 30 | 1.5 | - |
| toff, ts, tf | 2N869A | +6.0 | -4.0 | 2.0 | 62 | 30 | 1.5 | 1.5 |
| | 2N4453 | +6.0 | -4.0 | 3.0 | 91 | 30 | 1.5 | 1.5 |

(3) I_C/I_B = 10. Switching is shown to reflect current industry practices. Compare the values shown in Figures 1 and 2 ₱ I_C = 30 mA to the typical values in the Electrical Characteristics table ₱ I_C/I_B = 20.

FIGURE 2 - DC CURRENT GAIN

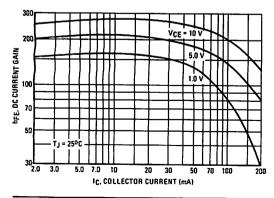
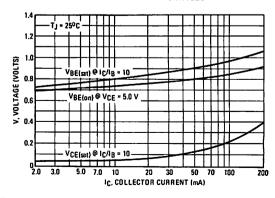


FIGURE 3 — "ON" VOLTAGES



SMALL-SIGNAL DEVICES

MOTOROLA SEMICONDUCTORS

⁽²⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.

⁽⁴⁾ $I_{B1} = I_{B2} = 3.0 \text{ mA} \oplus I_{C}/I_{B} = 10$

FIGURE 4 — CURRENT-GAIN — BANDWIDTH PRODUCT

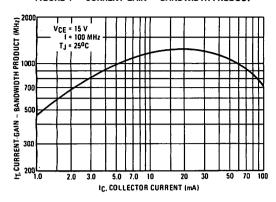


FIGURE 5 — TURN-ON TIME

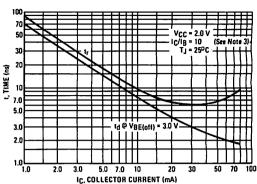
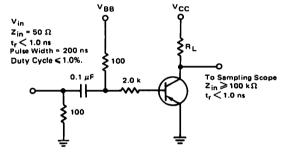
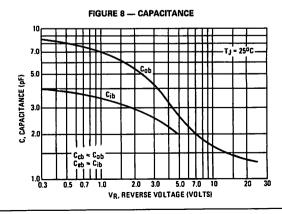


FIGURE 7 — SWITCHING TIME TEST CIRCUIT





MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|--------------------|---------------|
| Collector-Emitter Voltage | VCEO | 60 | Vdc |
| Collector-Emitter Voltage (RBE = 10 Ohms) | VCER | 80 | Vdc |
| Collector-Base Voltage | V _{CBO} | 100 | Vdc |
| Emitter-Base Voltage | VEBO | 7.0 | Vdc |
| Collector Current — Continuous | lc | 1.0 | Amp |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 0.5 2.86 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C T _C = 100°C Derate above 25°C | PD | 1.8 1.0 10.3 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 97.4 | °C/W |
| Thermal Resistance, Junction to Ambient | RAIA | 350 | °C/W |

2N910

CASE 22-03, STYLE 1 TO-18 (TO-206AA)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to 2N3019 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|---|-----------------------|----------------|-------------|--------|
| OFF CHARACTERISTICS | - | | | |
| Collector-Emitter Breakdown Voltage (I _C = 100 mAdc, R _{BE} ≤ 10 ohms)(1) | VCER(sus) | 80 | _ | Vdc |
| Collector-Emitter Sustaining Voltage (IC = 30 mAdc, IB = 0)(1) | V _{CEO(sus)} | 60 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μAdc, IE = 0) | V _{(BR)CBO} | 100 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | V(BR)EBO | 7.0 | _ | Vdc |
| Collector Cutoff Current ($V_{CB} = 75 \text{ Vdc}$, $t_E = 0$) ($V_{CB} = 75 \text{ Vdc}$, $t_E = 0$, $t_A = 150^{\circ}\text{C}$) | ІСВО | = | 0.025 15 | μAdc |
| Emitter Cutoff Current (VBE = 5.0 Vdc, IC = 0) | I _{EBO} | _ | 0.025 | μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 0.1 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc, T _A = -55°C) | phE | 35 75 30 | | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc) | V _{CE(sat)} | = | 0.4 1.2 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc) | V _{BE(sat)} | 0.6 | 0.8 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 10 Vdc, f = 20 MHz) | fΤ | 60 | | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | Copo | _ | 15 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = 0, f = 100 kHz) | Cibo | | 85 | pF |
| Input Impedance (I _C = 5.0 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 kHz) | h _{ie} | | 1800 | Ohms |
| Input Impedance (IC = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) (IC = 5.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) | h _{ib} | 20 4.0 | 30 8.0 | Ohms |
| Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) | h _{rb} | _ | 3.0 | X 10-4 |
| Small-Signal Current Gain (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 kHz) | h _{fe} | 76 | 200 | |
| Output Admittance (IC = 5.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | h _{Oe} | | 100 | μmhos |
| Output Admittance (I _C = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) (I _C = 5.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) | h _{ob} | | 0.5 1.0 | μmho |
| Noise Figure (IC = 0.3 mAdc, V_{CB} = 10 Vdc, R_G = 510 ohms, f = 1.0 kHz, B W = 200 Hz) | NF | - | 12 | dB |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle = 2.0%.

JAN, JTX AVAILABLE CASE 22, STYLE 1 TO-18 (TO-206AA)

SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MAXIMUM RATINGS | | | |
|---|-----------------------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 15 | Vdc |
| Collector-Emitter Voltage (RBE ≤ 10 ohms) | VCER | 20 | Vdc |
| Collector-Base Voltage | VCBO | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous(1) | lc | 150 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 360 2.06 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 6.8 | Watts mW/°C |
| Total Device Dissipation @ T _C = 100°C Derate above 100°C | PD | 0.68 | Watt |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

Refer to 2N2368 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|-----------------------|----------------|---------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(2) (I _C = 30 mAdc, R _{BE} ≤ 10 ohms) | V _{CER(sus)} | 20 | - | Vdc |
| Collector-Emitter Sustaining Voltage(2) (IC = 30 mAdc, IB = 0) | VCEO(sus) | 15 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 1.0 μAdc, I _E = 0) | V(BR)CBO | 40 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 20 Vdc, VBE = 0.25 Vdc, TA = 125°C) | ICEX | | 10 | μAdc |
| Collector Cutoff Current (V _{CB} = 20 Vdc, I_E = 0) (V _{CB} = 20 Vdc, I_E = 0, T _A = 150°C) | СВО | _ | 0.025 15 | μAdc |
| Emitter Cutoff Current (VBE = 4.0 Vdc, IC = 0) | lEBO | _ | 0.1 | μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain(2) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc, T _A = -55°C) (I _C = 500 mAdc, V _{CE} = 5.0 Vdc) | hFE | 30 12 10 | 120 — — | |
| Collector-Emitter Saturation Voltage(2) (I _C = 200 mAdc, I _B = 20 mAdc) (I _C = 10 mAdc, I _B = 1.0 thru 20 mAdc, T _A = -55 to +125°C) | VCE(sat) | = | 0.70 0.25 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | V _{BE(sat)} | 0.70 | 0.80 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 20 mAdc, VCE = 10 Vdc, f = 100 MHz) | fT | 300 | _ | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | _ | 6.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | C _{ibo} | | 9.0 | pF |
| SWITCHING CHARACTERISTICS | | | | |
| Storage Time(3) ($I_C = I_{B1} = I_{B2} = 20 \text{ mAdc}$) | tg | _ | 20 | ns |
| Turn-On Time(3) (I _C = 200 mAdc, I _{B1} = 40 mAdc, I _{B2} = 20 mAdc) | ton | - | 40 | ns |
| Turn-Off Time(3) (I _C = 200 mAdc, I _{B1} = 40 mAdc, I _{B2} = 20 mAdc) | t _{off} | _ | 40 | ns |

- (1) Limited by Power Dissipation.
- (2) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 1.0%.
- (3) Measured on Sampling Scope: Pulse Width ≥ 200 ns.

CASE 22, STYLE 1 TO-18 (TO-206AA)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|--------------|----------------|
| Collector-Emitter Voltage | VCEO | 50 | Vdc |
| Collector-Base Voltage | VCBO | 70 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.36 2.05 | Watts mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 6.81 | Watts mW/°C |
| Total Power Dissipation @ + 100°C Case | PD | 0.68 | w |
| Operating and Storage Temperature Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

Refer to 2N3946 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| 50 50 5.0 — — 50 50 tt) — | 0.010 0.010 0.010 200 1.0 | Vdc Vdc Vdc μA |
|---------------------------|-------------------------------|--|
| 70 70 5.0 5.0 — — — — 50 | 0.010 0.010 0.010 30 | Vdc Vdc μA μA |
| 50 5.0 — — — — — — 50 | 0.010 0.010 30 | Vdc μA μA |
| 50 | 0.010 0.010 30 | μΑ μΑ |
| | 0.010 30 200 | μΑ |
| | 200 | _ |
| | | - |
| | | - |
| t) — | 1.0 | 144- |
| | - 1 | Vdc |
| t) — | 0.9 | Vdc |
| , L | | - L |
| _ | 3.5 | pF |
| | 10 | pF |
| = | 6000 2000 | ohms |
| 2.5 | _ | _ |
| 40 50 | 200 250 | _ |
| _ | 75 125 | μmhos μmho |
| | 300 | ps |
| | 2.5 40 50 | - 3.5 - 10 - 6000 - 2000 2.5 - 40 200 50 250 - 75 - 125 |

SMALL-SIGNAL DEVICES

JAN AVAILABLE CASE 22, STYLE 1 TO-18 (TO-206AA)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MPONIMON IDALINGO | | | |
|---|-----------------------------------|--------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 25 | Vdc |
| Collector-Base Voltage | VCBO | 45 | Vdc |
| Emitter-Base Voltage | VEBO | 5 | Vdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.36 2.06 | Watts mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 6.9 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

Refer to 2N3946 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|--|-----------------------|--------------|--------------|--------------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Sustaining Voltage(1) (IC = 30 mA, IB = 0) | V _{CEO(sus)} | 25 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μA, I _E = 0) | V(BR)CBO | 45 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μA, I _C = 0) | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 30 V, IE = 0) | ІСВО | | 10 | nAdc |
| Collector Cutoff Current @ 150°C (VCB = 30 V, IE = 0) | Ісво | _ | 10 | μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain(1) (IC = 10 mA, VCE = 1.0 V) (IC = 10 mA, VCE = 1.0 V, -55°C) | hFE | 50 15 | 200 | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mA, I _B = 1.0 mA) | V _{CE(sat)} | _ | 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mA, IB = 1.0 mA) | V _{BE(sat)} | | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Output Capacitance (V _{CB} = 5.0 V, I _E = 0) | C _{obo} | _ | 6.0 | pF |
| Input Capacitance (VEB = 0.5 V, IC = 0) | C _{ibo} | _ | 10 | pF |
| Input Impedance, f = 1.0 kHz (I _C = 1.0 mA, V _{CE} = 5.0 V) (I _C = 5.0 mA, V _{CE} = 5.0 V) | h _{ie} | = | 6000 2000 | ohms ohms |
| Small-Signal Current Gain, f = 1.0 kHz (IC = 1.0 mA, VCE = 5.0 V) (IC = 5.0 mA, VCE = 5.0 V) | h _{fe} | 40 50 | 200 250 | _ |
| Magnitude of Forward Circuit Transfer Ratio, Common-Emitter (I _C = 10 mA, V _{CE} = 15 V) | h _{fe} | 3.0 | _ | _ |
| Output Admittance, f = 1.0 kHz (I _C = 1.0 mA, V _{CE} = 5.0 V) (I _C = 5.0 mA, V _{CE} = 5.0 V) | hoe | - | 75 125 | μmho μmho |
| Collector Base Time Constant (I _C = 10 mA, V _{CB} = 10 V, f = 40 MHz) | rb'C _C | _ | 300 | ps |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 1.0%.

JAN, JTX, JTXV AVAILABLE CASE 20-03, STYLE 10 (TO-72 (TO-206AF)

AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|-------------|
| Collector-Emitter Voltage | VCEO | 15 | Vdc |
| Collector-Base Voltage | VCBO | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | lc | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 200 1.14 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 300 1.71 | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

| Characteristic | Symbol | Min | Max | Unit |
|---|----------------------|-----|-------------|--------------|
| OFF CHARACTERISTICS | | _ | | |
| Collector-Emitter Sustaining Voltage (IC = 3.0 mAdc, IB = 0) | VCEO(sus) | 15 | - | Vdc |
| Collector-Base Breakdown Voltage (I _C = 1.0 μAdc, I _E = 0) | V(BR)CBO | 30 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 μ Adc, IC = 0) | V(BR)EBO | 3.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) (VCB = 16 Vdc, IE = 0, TA = 150°C) | СВО | - | .010 1.0 | μAdc μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gein (IC = 3.0 mAdc, VCE = 1.0 Vdc) | hFE | 20 | _ | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | V _{CE(sat)} | _ | 0.4 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | V _{BE(sat)} | _ | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product(1) (I _C = 4.0 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | ft | 600 | - | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 140 kHz) (V _{CB} = 0, I _E = 0, f = 140 kHz) | C _{obo} | _ | 1.7 | pF |
| Input Capacitance (VEB = 0.5 Vdc, IC = 0, f = 140 kHz) | C _{ibo} | | 2.0 | pF |
| Noise Figure (I _C = 1.0 mAdc, V_{CE} = 6.0 Vdc, R_{G} = 400 Ohms, f = 60 MHz) | NF | | 6.0 | dB |
| FUNCTIONAL TEST | | - | | |
| Amplifier Power Gain (V _{CB} = 12 Vdc, I _C = 6.0 mAdc, f = 200 MHz) | Gpe | 15 | | dB |
| Power Output $(V_{CB} = 15 \text{ Vdc}, I_{C} = 8.0 \text{ mAdc}, f = 500 \text{ MHz})$ | Po | 30 | | mW |
| Collector Efficiency (V _{CB} = 15 Vdc, I _C = 8.0 mAdc, f = 500 MHz) | η | 25 | – | % |

2N930,A

JAN, JTX AVAILABLE CASE 22, STYLE 1 TO-18 (TO-206AA)

AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | 2N930 | 2N930A | Unit |
|---|-----------------------------------|-------------|--------------|---------------|
| Collector-Emitter Voltage | VCEO | 45 | 60 | Vdc |
| Collector-Base Voltage | VCBO | 45 | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | 6.0 | Vdc |
| Collector Current | lc | 30 | | mAdc |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 0.5 3.33 | | W mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.8 12 | | Watt mW/°C |
| Operating and Storage Temperature Temperature Range | T _J , T _{stg} | -65 to | -65 to + 175 | |

Refer to 2N2481 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|-----------------|----------|------------|------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (1) (IC = 10 mAdc, IB = 0) | | V(BR)CEO | 45 | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | 2N930A | V(BR)CBO | 80 | 1 | Vdc |
| {IE = 10 μAdc, IC = 0} | 2N930 2N930A | V(BR)EBO | 5.0 6.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 5.0 Vdc, IB = 0) | | ICEO | - | 2.0 | nAdc |
| Collector Cutoff Current (VCB = 45 Vdc, IE = 0) | 2N930 2N930A | lСВО | 1 1 | 10 2.0 | nAdc |
| Collector Cutoff Current (VCE = 45 Vdc, VBE = 0) | 2N930 2N930A | CES | - | 10 2.0 | nAdc |
| (V _{CE} = 45 Vdc, V _{BE} = 0, T _A = 170°C) | 2N930 2N930A | | 1-1 | 10 2.0 | μAdc |
| Emitter Cutoff Current (VBE = 5.0 Vdc, IC = 0) | 2N930 2N930A | EBO | 1 1 | 10 2.0 | nAdc |
| ON CHARACTERISTICS | - | | | | |
| DC Current Gain (IC = 1.0 μAdc, VCE = 5.0 Vdc) | 2N930A | hFE | 60 | _ | _ |
| (I _C = 10 μAdc, V _{CE} = 5.0 Vdc) | 2N930 2N930A | | 100 | 300 | |
| (I _C = 10 μAdc, V _{CE} = 5.0 Vdc, T _A = -55°C) | 2N930 2N930A | | 20 30 | _ | |
| (I _C = 500 μAdc, V _{CE} = 5.0 Vdc) | 2N930 2N930A | | 150 — | = | |
| (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) (1) | 2N930 2N930A | | _ | 600 600 | |

2N930,A

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|--|------------------|----------------------|--------------|------------|--------|
| Collector-Emitter Saturation Voltage (1) (I _C = 10 mAdc, I _B = 0.5 mAdc) | 2N930 2N930A | VCE(sat) | = | 1.0 0.5 | Vdc |
| Base-Emitter Saturation Voltage (1) (I _C = 10 mAdc, I _B = 0.5 mAdc) | 2N930 2N930A | V _{BE(sat)} | 0.7 | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | • |
| Current-Gain — Bandwidth Product (IC = 500 µAdc, VCE = 5.0 Vdc, f = 30 MHz) | 2N930 2N930A | ft | 30 45 | _ | MHz |
| Output Capacitance (V _{CB} = 5.0 Vdc, l _E = 0, f = 1.0 MHz) | 2N930 2N930A | C _{obo} | - | 8.0 6.0 | pF |
| Input Impedance (I _E = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) | | hib | 25 | 32 | ohms |
| Voltage Feedback Ratio (I _E = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) | | h _{rb} | _ | 600 | X 10-6 |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | 2N930 2N930A | h _{fe} | 150 | 600 | _ |
| Output Admittance (IE = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) | | h _{ob} | _ | 1.0 | μmhos |
| Noise Figure (I _C = 10 μ Adc, V _{CE} = 5.0 Vdc, R _S = 10 k ohms, f = 10 Hz to 15.7 kHz) | 2N930, 2N930A | NF | _ | 3.0 | dB |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

2N1132,A

JAN AVAILABLE CASE 79-02, STYLE 1 TO-39 (TO-205AD)

SWITCHING TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| MAXIMOM PATINGS | | | | |
|---|-----------------------------------|-----------|----------------------|-------|
| Rating | Symbol | 2N1132 | 2N1132A | Unit |
| Collector-Emitter Voltage | VCEO | 35 | 40 | Vdc |
| Collector-Emitter Voltage (RBE ≤ 10 Ohms) | VCER | ←! | 50 | Vdc |
| Collector-Base Voltage | V _{CBO} | 50 | 60 | Vdc |
| Emitter-Base Voltage | VEBO | | 5.0 → | Vdc |
| Collector Current — Continuous | ľC | 6 | 00 —→ | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | | ← 600 → ← 3.43 → | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | | ← 2.0 → ← 11.43 → | |
| Total Device Dissipation @ T _C = 100°C 2N1132A | PD | ←1 | .0 | Watts |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 t | o +200 | ℃ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|--------|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 87.49 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 291.55 | °C/W |

Refer to 2N2904 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|--|----------------------|------------------|--------------------------------|----------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 10 mA) | 2N1132A 2N1132 | V(BR)CEO | 40 35 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0) | 2N1132, 2N1132A | V(BR)CBO | 50 60 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 µAdc, IC = 0) (IE = 1.0 mA, IC = 0) | 2N1132, 2N1132A | V(BR)EBO | 5.0 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0) (VCB = 50 Vdc, IE = 0) (VCB = 30 Vdc, IE = 0, TA = 150°C) (VCB = 45 Vdc, IE = 0, TA = 150°C) (VCB = 45 Vdc, IE = 0, TA = 150°C) | 2N1132 2N1132 2N1132 2N1132A 2N1132A | ICBO | _ _ _ _ | 1.0 100 100 0.5 50 | μAdc |
| Collector Cutoff Current (VCE = 50 V, RBE = ≤ 10 Ohms) | 2N1132 2N1132A | ¹ CER | | 10 10 | mA mA |
| Emitter Cutoff Current (VBE = 5.0 Vdc, IC = 0) (VBE = 2.0 Vdc, IC = 0) | 2N1132A 2N1132 | IEBO | = | 100 100 | μAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain (I _C = 5.0 mAdc, V_{CE} = 10 Vdc) (I _C = 150 mAdc, V_{CE} = 10 Vdc) | | hFE | 25 30 | 90 | _ |
| Collector-Emitter Saturation Voltage (IC = 150 mAdc, Ig = 15 mAdc) | | VCE(sat) | _ | 1.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) | | V _{BE(sat)} | _ | 1.3 | Vdc |

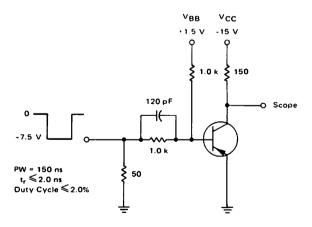
2N1132,A

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|---|--------------------|------------------|----------|------------|--------|
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 10 Vdc, f = 20 MHz) | | fτ | 60 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, I_E = 0, f = 1.0 MHz) (VCB = 10 Vdc, I_E = 0, f = 1.0 MHz) | 2N1132, 2N1132A | C _{obo} | = | 45 30 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 1.0 kHz) (VBE = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | 2N1132, 2N1132A | Cibo | = | 80 80 | pF |
| Input Impedance (I _C = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz (I _C = 5.0 mAdc, V _{CB} = 10 Vdc, f = 1.0 kHz | | hib | 25 — | 35 10 | Ohms |
| Voltage Feedback Ratio {I _C = 5.0 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 kHz} (I _C = 5.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz} | | hrb | _ | 8.0 8.0 | X 10-4 |
| Small-Signal Current Gain (I _C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz) | 2N1132, 2N1132A | h _{fe} | 25 25 | 100 75 | _ |
| (IC = 5.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | 2N1132, 2N1132A | | 30 30 | _ | |
| Output Admittance (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 kHz) (I _C = 5.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | | h _{ob} | <u>-</u> | 1.0 5.0 | μmhos |
| SWITCHING CHARACTERISTICS | | | | • | |
| Turn-On Time | 2N1132A | ton | _ | 45 | ns |
| Turn-Off Time | 2N1132A | toff | | 35 | ns |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

FIGURE 1 SWITCHING TIMES TEST CIRCUIT



JAN, JTX, JTXV AVAILABLE CASE 79-02, STYLE 1 TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|--------------|----------------|
| Collector-Emitter Voltage (RBE ≤ 10 Ohms) | VCER | 50 | Vdc |
| Collector-Base Voltage | V _{CBO} | 75 | Vdc |
| Emitter-Base Voltage | VEBO | 7.0 | Vdc |
| Collector Current — Continuous | lc | 500 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.8 4.57 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 3.0 17.15 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|--------------------------------------|--------|------|------|
| Thermal Resistance, Junction to Case | RAJC | 58.3 | °C/W |

Refer to 2N3019 for graphs.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|-----------------------|----------------------------|---------------------------|---------------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 100 mAdc, RBE ≤ 10 Ohms) | V _{CER(sus)} | 50 | 1 | ı | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0) | V(BR)CBO | 75 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 µAdc, IC = 0) | V(BR)EBO | 7.0 | _ | _ | Vdc |
| Collector Cutoff Current $\{VCB = 60 \text{ Vdc}, _{E} = 0\}$ $\{VCB = 60 \text{ Vdc}, _{E} = 0, T_{A} = 150^{\circ}\text{C}\}$ | СВО | 1 1 | 1 1 | 10 10 | nAdc µAdc |
| Emitter Cutoff Current (VEB = 5.0 Vdc, IC = 0) | [[] EBO | _ | _ | 10 | nAdc |
| ON CHARACTERISTICS(1) | | - | | | |
| DC Current Gain (I _C = 100 μ Adc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc, T _A = -55° C) (I _C = 150 mAdc, V _{CE} = 10 Vdc) (I _C = 500 mAdc, V _{CE} = 10 Vdc) | hFE | 20 35 20 40 20 | 35 50 — 80 30 | 120 | _ |
| Collector-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) | V _{CE(sat)} | _ | 0.3 | 1.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) | V _{BE(sat)} | - | 0.78 | 1.3 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product(1) (IC = 50 mAdc, VCE = 10 Vdc, f = 20 MHz) | fΤ | 60 | _ | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | Cobo | | 10 | 25 | pF |
| Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 100 kHz) | Cibo | - | 50 | 80 | ρF |
| Input Impedance (IC = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) (IC = 5.0 mAdc, V _{CB} = 10 Vdc, f = 1.0 kHz) | hib | 24 4.0 | _ | 34 8.0 | Ohms |
| Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) (I _C = 5.0 mAdc, V _{CB} = 10 Vdc, f = 1.0 kHz) | h _{rb} | 1.1 | _ | 3.0 3.0 | X 10-4 |
| Small-Signal Current Gain (I _C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz) (I _C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) | h _{fe} | 30 35 | _ | 100 150 | _ |
| Output Admittance (I _C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz) (I _C = 5.0 mAdc, V_{CB} = 10 Vdc, f = 1.0 kHz) | h _{ob} | 0.05 0.05 | | 0.5 0.5 | μmhos |
| Noise Figure (IC = 0.3 mAdc, VCE = 10 Vdc, RS = 510 Ohms, f = 1.0 kHz, Bandwidth = 1.0 Hz) | NF | _ | _ | 12 | dB |
| SWITCHING CHARACTERISTICS | | | | | |
| Switching Time | td+tr+tf | | _ | 30 | ns |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

For Specifications, See 2N718A Data.

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|----------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 80 | Vdc |
| Collector-Emitter Voltage | VCER | 100 | Vdc |
| Collector-Base Voltage | VCBO | 120 | Vdc |
| Emitter-Base Voltage | VEBO | 7.0 | Vdc |
| Collector Current — Continuous | lc | 0.5 | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.8 4.57 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 3.0 17.2 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, Tstg | -65 to +200 | ℃ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|-------------------|------|------|
| Thermal Resistance, Junction to Case | RøJC | 58.3 | •c/w |
| Thermal Resistance, Junction to Ambient | R _B JA | 219 | °C/W |

2N1893

CASE 79, STYLE 1 TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to 2N3019 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|----------------------|----------------------|--------------------|--------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 100 mAdc, R _{BE} = 10 ohms) | VCER(sus) | 100 | _ | Vdc |
| Collector-Emitter Sustaining Voltage(1) (IC = 30 mAdc, IB = 0) | VCEO(sus) | 80 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 120 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | V(BR)EBO | 7.0 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 90 Vdc, I _E = 0) (V _{CB} = 90 Vdc, I _E = 0, T _A = 150°C) | ІСВО | _ | 0.01 15 | μAdc |
| Emitter Cutoff Current (VBE = 5.0 Vdc, IC = 0) | IEBO | | 0.01 | μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain(1) (I _C = 0.1 mAdc, V_{CE} = 10 Vdc) (I _C = 10 mAdc, V_{CE} = 10 Vdc) (I _C = 10 mAdc, V_{CE} = 10 Vdc, T_{A} = -55°C) (I _C = 150 mAdc, V_{CE} = 10 Vdc) | hFE | 20 35 20 40 | _ _ _ 120 | _ |
| Collector-Emitter Saturation Voltage (IC = 50 mAdc, IB = 5.0 mAdc) (IC = 150 mAdc, IB = 15 mAdc) | VCE(sat) | | 1.2 5.0 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 50 mAdc, I _B = 5.0 mAdc) (I _C = 150 mAdc, I _B = 15 mAdc) | V _{BE(sat)} | = | 0.9 1.3 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 10 Vdc, f = 20 MHz) | fτ | 50 | _ | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, 100 kHz \leq f \leq 1.0 MHz) | Cobo | | 15 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I_C = 0, 100 kHz \leq f \leq 1.0 MHz) | Cibo | | 85 | pF |
| Input Impedance (IC = 1.0 mAdc, VCB = 5.0 Vdc, f = 1.0 kHz) (IC = 5.0 mAdc, VCB = 10 Vdc, f = 1.0 kHz) | hib | 20 4.0 | 30 8.0 | Ohms |
| Voltage Feedback Ratio (IC = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz) (IC = 5.0 mAdc, V_{CB} = 10 Vdc, f = 1.0 kHz) | h _{rb} | _ | 1.25 1.5 | X 10-4 |
| Small-Signal Current Gain (IC = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz) (IC = 5.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) | h _{fe} | 30 45 | 100 — | _ |
| Output Admittance (IC = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz) (IC = 5.0 mAdc, V_{CB} = 10 Vdc, f = 1.0 kHz) | h _{ob} | | 0.5 0.5 | μmho |

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 65 | Vdc |
| Collector-Emitter Voltage, RBE ≤ 10 Ohms | VCER | 80 | Vdc |
| Collector-Base Voltage | VCBO | 120 | Vdc |
| Emitter-Base Voltage | VEBO | 7.0 | Vdc |
| Collector Current — Continuous | lc | 1.0 | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.71 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|----------------------|-----|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 35 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{BJA} (1) | 175 | °C/W |

Refer to 2N3019 for graphs.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------------------|----------------------------------|------------|--------------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 100 mAdc, R _{BE} ≤ 10 ohms) | VCER(sus) | 80 | - | - | Vdc |
| Collector-Emitter Sustaining Voltage(2) (IC = 100 mAdc, IB = 0) | VCEO(sus) | 65 | - | _ | Vdc |
| Collector-Emitter Breakdown Voltage (I _C = 100 μAdc, V _{EB} = 1.5 Vdc) | V(BR)CEX | 120 | 1 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 120 | - | 1 | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | V(BR)EBO | 7.0 | - | - | Vdc |
| Collector Cutoff Current (V _{CB} = 60 Vdc, I _E = 0) (V _{CB} = 60 Vdc, I _E = 0, T _A = 150°C) | ІСВО | - | 1 1 | 2.0 2.0 | nAdc μAdc |
| Emitter Cutoff Current (VBE = 5.0 Vdc, IC = 0) | I _{EBO} | | _ | 2.0 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain ($I_C = 0.1 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$) ($I_C = 10 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$) ($I_C = 10 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$, $I_{CE} = 10 \text{ Vdc}$) ($I_{CE} = 10 \text{ mAdc}$, $I_{CE} = 10 \text{ Vdc}$)($I_{CE} = 10 \text{ Vdc}$) | hFE | 20 35 20 40 25 10 | 11111 | - - 120 - | |
| Collector-Emitter Saturation Voltage (IC = 150 mAdc, Ig = 15 mAdc) | V _{CE(sat)} | _ | 0.15 | 0.5 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc) | V _{BE(sat)} | _ | 0.88 | 1.1 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (I _C = 50 mAdc, V _{CE} = 10 Vdc, f = 20 MHz) | fT | 60 | _ | - | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | Cobo | _ | 6.0 | 15 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = 0, f = 100 kHz) | C _{ibo} | _ | 50 | 80 | pF |
| Input Impedance (IC = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz) (IC = 5.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) | hib | 24 4.0 | | 34 8.0 | Ohms |
| Voltage Feedback Ratio (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) (IC = 5.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{rb} | | _ | 3.0 3.0 | X 10-4 |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) (IC = 5.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{fe} | 30 35 | = | 100 150 | - |
| Output Admittance (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 kHz) (I _C = 5.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{ob} | 0.01 0.01 | _ | 0.5 1.0 | μmho |
| Noise Figure (I _C = 300 µAdc, V _{CE} = 10 Vdc, R _S = 1.0 k Ohm, f = 1.0 kHz, Bandwidth = 1.0 Hz) | NF | _ | 4.0 | 6.0 | dB |
| SWITCHING CHARACTERISTICS | | | | | |
| Switching Time | td + tr + tf | | | 30 | ns |
| 1) ReJA is measured with the device soldered into a typical printed circuit board. (2) Put | se Test: Pulse Wid | lth < 300 μs. | Duty Cycle | ≤ 2.0%. | |

MAXIMUM RATINGS

| WAXIIVOW NATINGS | | | |
|---|-----------------------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 50 | Vdc |
| Collector-Base Voltage | VCBO | 80 | Vdc |
| Emitter-Base Voltage | VEBO | 8.0 | Vdc |
| Collector Current — Continuous | lc | 1.0 | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.8 4.6 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.8 16 | Watts mW/°C |
| Total Device Dissipation @ 100°C Case Derate above 100°C | PD | 1.6 16 | mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

2N2193A

CASE 79, STYLE 1 TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to 2N3019 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|---|----------------------|----------------------------------|---------------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Sustaining Voltage(1) (IC = 25 mA, IB = 0) | VCEO(sus) | 50 | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, Ig = 0) | V(BR)CBO | 80 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 µAdc, I _C = 0) | V(BR)EBO | 8.0 | | Vdc |
| Collector Cutoff Current (VCB = 60 Vdc, IE = 0) (VCB = 60 Vdc, IE = 0, TA = 150°C) | СВО | = | 0.010 25 | μAdc |
| Emitter Cutoff Current (VEB = 5.0 Vdc, IC = 0) | !EBO | _ | 0.050 | μAdc |
| ON CHARACTERISTICS | | | -l | |
| DC Current Gain(1) (IC = 0.1 mAdc, VCE = 10 Vdc) (IC = 10 mAdc, VCE = 10 Vdc) (IC = 10 mAdc, VCE = 10 Vdc, T _A = -55°C) (IC = 150 mAdc, VCE = 10 Vdc)(1) (IC = 150 mAdc, VCE = 1.0 Vdc)(1) (IC = 500 mAdc, VCE = 10 Vdc)(1) (IC = 1.0 Adc, VCE = 10 Vdc)(1) | hfE | 15 30 20 40 30 20 | 120 | _ |
| Collector-Emitter Saturation Voltage (IC = 150 mAdc, Ig = 15 mAdc) | V _{CE(sat)} | _ | 0.25 | Vdc |
| Base-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) | V _{BE(sat)} | _ | 1.3 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | _ | 20 | pF |
| Small-Signal Current Gain (IC = 50 mA, VCE = 10 V, f = 20 MHz) | h _{fe} | 2.5 | _ | _ |
| SWITCHING CHARACTERISTICS | | | L | ı |
| Rise Time | tr | | 70 | ns |
| Storage Time | ts | | 150 | ns |
| Fall Time | tí | _ | 50 | ns |

Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

2N2218,A/2N2219,A 2N2221,A/2N2222,A 2N5581/82

JAN, JTX, JTXV AVAILABLE

2N2218,A 2N2219,A CASE 79-02 TO-39 (TO-205AD) 2N2221,A 2N2222,A CASE 22-03 TO-18 (TO-206AA) 2N5581 2N5582 CASE 26-03

TO-46 (TO-206AB) GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MDAMION IOTHIGO | | | | | |
|--|----------------------|--------------------------------------|--|------------------|----------------|
| Rating | Symbol | 2N2218 2N2219 2N2221 2N2222 | 2N2218A 2N2219A 2N2221A 2N2222A | 2N5581 2N5582 | Unit |
| Collector-Emitter Voltage | VCEO | 30 | 40 | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 60 | 75 | 75 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | 6.0 | 6.0 | Vdc |
| Collector Current — Continuous | lc | 800 | 800 | 800 | mAdc |
| | | 2N2218,A 2N2219,A | 2N2221,A 2N2222,A | 2N5581 2N5582 | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.8 4.57 | 0.4 2.28 | 0.6 3.33 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 3.0 17.1 | 1.2 6.85 | 2.0 11.43 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | - | 65 to + 200 |) | °c |

| Characteristic | | Symbol | Min | Max | Unit |
|--|--|----------|-------------|--------------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, I _B = 0) | Non-A Suffix A-Suffix, 2N5581, 2N5582 | V(BR)CEO | 30 40 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | Non-A Suffix A-Suffix, 2N5581, 2N5582 | V(BR)CBO | 60 75 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 μAdc, IC = 0) | Non-A Suffix A-Suffix, 2N5581, 2N5582 | V(BR)EBO | 5.0 6.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 60 Vdc, VEB(off) = 3.0 Vdc) | A-Suffix, 2N5581, 2N5582 | CEX | | 10 | nAdc |
| Collector Cutoff Current (V _{CB} = 50 Vdc, I _E = 0) (V _{CB} = 60 Vdc, I _E = 0) (V _{CB} = 50 Vdc, I _E = 0, T _A = 150°C) (V _{CB} = 60 Vdc, I _E = 0, T _A = 150°C) | Non-A Suffix A-Suffix, 2N5581, 2N5582 Non-A Suffix A-Suffix, 2N5581, 2N5582 | ICBO | - - - | 0.01 0.01 10 10 | μAdc |
| Emitter Cutoff Current (VEB = 3.0 Vdc, IC = 0) | A-Suffix, 2N5581, 2N5582 | IEBO | - | 10 | nAdc |
| Base Cutoff Current (VCE = 60 Vdc, VEB(off) = 3.0 Vdc) | A-Suffix | IBL | | 20 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 0.1 mAdc, V _{CE} = 10 Vdc) | 2N2218,A, 2N2221,A, 2N5581(1) 2N2219,A, 2N2222,A, 2N5582(1) | ptE | 20 35 | = | _ |
| $\{I_C = 1.0 \text{ mAdc, } V_{CE} = 10 \text{ Vdc}\}$ | 2N2218,A, 2N2221,A, 2N5581 2N2219,A, 2N2222,A, 2N5582 | | 25 50 | = | |
| $(I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})$ | 2N2218,A, 2N2221,A, 2N5581(1) 2N2219,A, 2N2222,A, 2N5582(1) | | 35 75 | = | |
| $(I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, T_A = -55^{\circ}C)$ | 2N2218A, 2N2221A, 2N5581 2N2219A, 2N2222A, 2N5582 | | 15 35 | = | ļ |
| (IC = 150 mAdc, VCE = 10 Vdc)(1) | 2N2218,A, 2N2221,A, 2N5581 2N2219,A, 2N2222,A, 2N5582 | | 40 100 | 120 300 | |

2N2218/19/21/22, A SERIES, 2N5581/82

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

| Characteristic | TIA 20 0 UNIOSS OTHERWISE HOLE | Symbol | Min | Max | Unit |
|--|--|----------------------|----------------------|-------------|--------|
| (I _C = 150 mAdc, V _{CE} = 1.0 Vdc)(1) | 2N2218,A, 2N2221,A, 2N5581 2N2219,A, 2N2222,A, 2N5582 | 1 | 20 50 | = | |
| (I _C = 500 mAdc, V _{CE} = 10 Vdc)(1) | 2N2218, 2N2221 2N2219, 2N2222 2N2218A, 2N2221A, 2N5581 2N2219A, 2N2222A, 2N5582 | | 20 30 25 40 | = | |
| Collector-Emitter Saturation Voltage(1) (IC = 150 mAdc, Ig = 15 mAdc) | Non-A Suffix A-Suffix, 2N5581, 2N5582 | VCE(sat) | - | 0.4 0.3 | Vdc |
| (I _C = 500 mAdc, I _B = 50 mAdc) | Non-A Suffix A-Suffix, 2N5581, 2N5582 | | _ | 1.6 1.0 | |
| Base-Emitter Saturation Voltage(1) (I _C = 150 mAdc, I _B = 15 mAdc) | Non-A Suffix A-Suffix, 2N5581, 2N5582 | VBE(sat) | 0.6 0.6 | 1.3 1.2 | Vdc |
| (IC = 500 mAdc, IB = 50 mAdc) | Non-A Suffix A-Suffix, 2N5581, 2N5582 | | 1 1 | 2.6 2.0 | |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product(2) (I _C = 20 mAdc, V _{CE} = 20 Vdc, f = 100 MHz) | All Types, Except 2N2219A, 2N2222A, 2N5582 | fτ | 250 300 | _ | MHz |
| Output Capacitance(3) (VCB = 10 Vdc, IE = 0, f = 100 kHz) | | C _{obo} | _ | 8.0 | pF |
| Input Capacitance(3) (VEB = 0.5 Vdc, IC = 0, f = 100 kHz) | Non-A Suffix A-Suffix, 2N5581, 2N5582 | C _{ibo} | 1 1 | 30 25 | pF |
| Input Impedance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | 2N2218A, 2N2221A 2N2219A, 2N2222A | h _{ie} | 1.0 2.0 | 3.5 8.0 | kohms |
| (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | 2N2218A, 2N2221A 2N2219A, 2N2222A | | 0.2 0.25 | 1.0 1.25 | |
| Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | 2N2218A, 2N2221A 2N2219A, 2N2222A | h _{re} | <u>-</u> | 5.0 8.0 | X 10-4 |
| (IC = 10 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | 2N2218A, 2N2221A 2N2219A, 2N2222A | | _ | 2.5 4.0 | |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | 2N2218A, 2N2221A 2N2219A, 2N2222A | h _{fe} | 30 50 | 150 300 | _ |
| (IC = 10 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | 2N2218A, 2N2221A 2N2219A, 2N2222A | | 50 75 | 300 375 | |
| Output Admittance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | 2N2218A, 2N2221A 2N2219A, 2N2222A | h _{OB} | 3.0 5.0 | 15 35 | μmhos |
| (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | 2N2218A, 2N2221A 2N2219A, 2N2222A | | 10 25 | 100 200 | 1 |
| Collector Base Time Constant (I _E = 20 mAdc, V _{CB} = 20 Vdc, f = 31.8 MHz) | A-Suffix | rb'C _C | | 150 | ps |
| Noise Figure (IC = 100 μ Adc, V _{CE} = 10 Vdc, R _S = 1.0 kohm, f = 1.0 kHz) | 2N2219A, 2N2222A | NF | _ | 4.0 | dB |
| Real Part of Common-Emitter High Frequency Input Impedance (IC = 20 mAdc, VCE = 20 Vdc, f = 300 MHz) (1) Pulse Test: Pulse Width \(\ll \) 300 \(\mu \text{s} \), Duty Cycle \(\ll \) | 2N2218A, 2N2219A 2N2221A, 2N2222A | Re(h _{ie}) | - | 60 | Ohms |

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%. (2) fT is defined as the frequency at which $|h_{fe}|$ extrapolates to unity. (3) 2N5581 and 2N5582 are Listed C_{cb} and C_{eb} for these conditions and values.

2N2218,A/2N2219,A/2N2221,A/2N2222,A/2N5581/82

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| | Characteristic | Symbol | Min | Max | Unit |
|--|--|--------|-----|-----|------|
| SWITCHING CHARA | CTERISTICS | | | | |
| Delay Time | (VCC = 30 Vdc, VBE(off) = 0.5 Vdc, | td | - | 10 | ns |
| Rise Time | I _C = 150 mAdc, I _{B1} = 15 mAdc) (Figure 14) | tr | - | 25 | ns |
| Storage Time | (V _{CC} = 30 Vdc, I _C = 150 mAdc, | ts | _ | 225 | ns |
| Fall Time | I _{B1} = I _{B2} = 15 mAdc) (Figure15) | tf | - | 60 | ns |
| Active Region Time (IC = 150 mAdc, \ 2N2221A, 2N2222 | /CE = 30 Vdc) (See Figure 14 for 2N2218A, 2N2219A, | TA | - | 2.5 | ns |

FIGURE 1 - NORMALIZED DC CURRENT GAIN

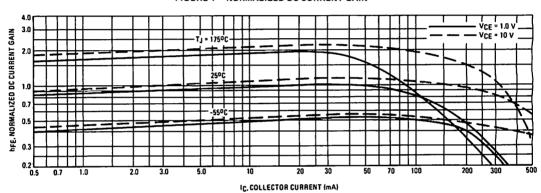
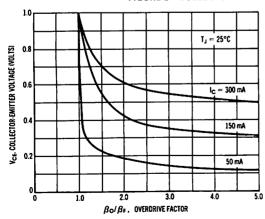


FIGURE 2 - COLLECTOR CHARACTERISTICS IN SATURATION REGION



This graph shows the effect of base current on collector current. β_0 (current gain at the edge of saturation) is the current gain of the transistor at 1 volt, and β_r (forced gain) is the ratio of I_c/I_p in a circuit.

EXAMPLE: For type 2N2219, estimate a base current (I_{p}) to insure saturation at a temperature of 25°C and a collector current of 150 mA.

Observe that at $l_c=150$ mA an overdrive factor of at least 2.5 is required to drive the transistor well into the saturation region. From Figure 1, it is seen that $h_{\rm H}$ @ 1 volt is approximately 0.62 of $h_{\rm H}$ @ 10 volts. Using the guaranteed minimum gain of 100 @ 150 mA and 10 V, $\beta_o=62$ and substituting values in the overdrive equation, we find:

$$\frac{\beta_{o}}{\beta_{s}} = \frac{h_{H} @ 1.0 \text{ V}}{I_{c}/I_{sc}}$$
 2.5 = $\frac{62}{150/I_{sc}}$ $I_{sc} \approx 6.0 \text{ mA}$

2N2218,A/2N2219,A/2N2221,A/2N2222,A/2N5581/82

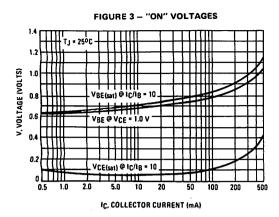
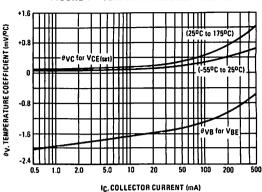


FIGURE 4 - TEMPERATURE COEFFICIENTS



h PARAMETERS

VCE = 10 Vdc, f = 1.0 kHz, TA = 25°C

This group of graphs illustrates the relationship between high and other "h" parameters for this series of transistors. To obtain these curves, a high-gain and a low-gain unit were selected and the same units were used to develop the correspondingly numbered curves on each graph.

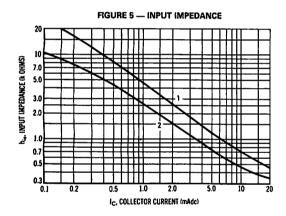
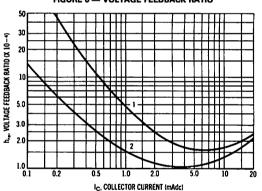


FIGURE 6 — VOLTAGE FEEDBACK RATIO



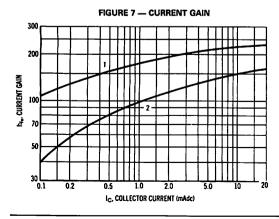
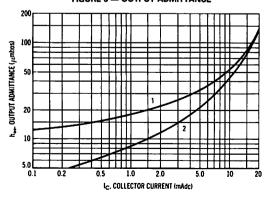
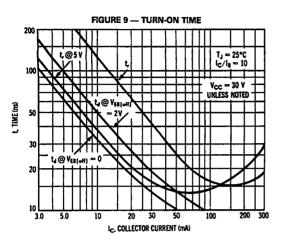
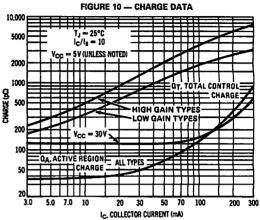


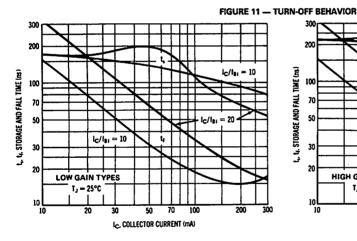
FIGURE 8 — OUTPUT ADMITTANCE

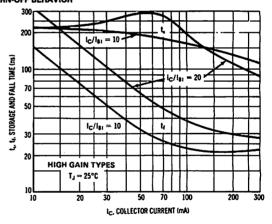


SWITCHING TIME CHARACTERISTICS









2N2218,A/2N2219,A/2N2221,A/2N2222,A/2N5581/82

FIGURE 12 — DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT

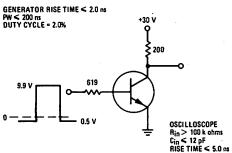
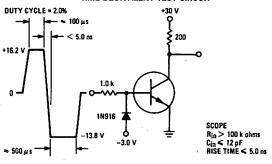


FIGURE 13 — STORAGE TIME AND FALL TIME EQUIVALENT TEST CIRCUIT



CASE 79-02, STYLE TO-39 (TO-205AD)

AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| IIIAAIIIOIII IIAI IIIOO | | | |
|---|-----------------------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 45 | Vdc |
| Collector-Emitter Voltage, RBE ≤ 10 Ohms | VCER | 60 | Vdc |
| Collector-Base Voltage | V _{CBO} | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 7.0 | Vdc |
| Collector Current — Continuous | lc | 1.0 | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.71 | Watt mW/℃ |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|----------------------|-----|------|
| Thermal Resistance, Junction to Case | RøJC | 35 | •c/w |
| Thermal Resistance, Junction to Ambient | R _{BJA} (1) | 175 | °C/W |

Refer to 2N3019 for graphs.

| ELECTRICAL CHARACTERISTICS (1A = 25 C unless circle vise noted.) | , | | | | |
|---|--|----------|-----------|-------------|------|
| Characteristic | Symbol | Min | Тур | Max | Unit |
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (I _C = 100 mAdc, R _{BE} ≤ 10 Ohms) | V(BR)CER | 60 | _ | - | Vdc |
| Collector-Emitter Sustaining Voltage(2) (IC = 100 mAdc, IB = 0) | VCEO(sus) | 45 | _ | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.05 µAdc, IE = 0) | V(BR)CBO | 60 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 0.1 mAdc, IC = 0) | V(BR)EBO | 7.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 60 Vdc, I _E = 0, T _C = 25°C) (VCB = 60 Vdc, I _E = 0, T _C = 150°C) | ІСВО | 1 1 | <u>-</u> | 0.05 100 | μAdc |
| Emitter Cutoff Current (VBE = 5.0 Vdc, IC = 0) | lEBO | _ | | 100 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain {IC = 1.0 mAdc, VCE = 10 Vdc} {IC = 150 mAdc, VCE = 10 Vdc} | hFE | 30 50 | 90 135 | _ 200 | _ |
| Collector-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc) | V _{CE(sat)} | _ | 0.15 | 0.9 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc) | VBE(sat) | <u> </u> | 0.88 | 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (I _C = 50 mAdc, V _{CE} = 10 Vdc, f = 20 MHz) | fτ | 100 | 250 | _ | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, _E = 0, f = 100 kHz) | C _{obo} | _ | 10 | 15 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = 0, f = 100 kHz) | C _{ibo} | _ | 60 | 80 | ρF |
| Small-Signal Current Gain (I _C = 5.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{fe} | 50 | _ | 275 | _ |
| Noise Figure (I _C = 0.3 mAdc, V _{CE} = 10 Vdc, R _S = 1.0 k Ohm, f = 1.0 kHz, B.W. = 1.0 Hz) | NF | _ | 7.0 | 10 | dB |
| SWITCHING CHARACTERISTICS | | | | | |
| Total Switching Time | ton + toff | _ | | 30 | ns |

⁽¹⁾ R_{6JA} is measured with the device soldered into a typical printed circuit board. (2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 35 | Vdc |
| Collector-Base Voltage | V _{CBO} | 80 | Vdc |
| Emitter-Base Voltage | VEBO | 7.0 | Vdc |
| Collector Current — Continuous | Ιc | 1.0 | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 800 4.56 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, Tstg | -65 to +200 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|--|----------------------|-----|------|
| Thermal Resistance, Junction to Case | RAJC | 35 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 219 | °C/W |
| Lead Temperature, 1/16" from Case for 10 seconds | ΤL | 300 | °C |

2N2297

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N3019 for graphs.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------------------|----------------|----------------|---------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Sustaining Voltage(2) (IC = 30 mAdc, Ig = 0) | VCEO(sus) | 35 | - | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 80 | - | _ | Vdc |
| (I _E = 100 μAdc, I _C = 0) | V(BR)EBO | 7.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 60 Vdc, IE = 0) (VCB = 60 Vdc, IE = 0, TA = +150°C) | ІСВО | _ | _ | 10 10 | nAdc μAdc |
| Emitter Cutoff Current (VEB = 5.0 Vdc, I _C = 0) | leb0 | _ | _ | 10 | nAdc |
| ON CHARACTERISTICS(2) | | | | | |
| DC Current Gain (IC = 10 mAdc, V _{CE} = 10 Vdc) (IC = 150 mAdc, V _{CE} = 10 Vdc) (IC = 1.0 Adc, V _{CE} = 10 Vdc) | hFE | 30 40 15 | 60 80 40 | _ 120 _ | _ |
| Collector-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc) (I _C = 1.0 Adc, I _B = 100 mAdc) | V _{CE(sat)} | | 0.1 0.6 | 0.2 1.0 | Vdc |
| Base-Emitter Saturation Voltage (IC = 1.0 Adc, IB = 100 mAdc) | V _{BE(sat)} | | 0.8 | 1.6 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | · |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 10 Vdc, f = 20 MHz) | fŢ | 60 | 100 | _ | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | _ | 8.0 | 12 | pF |
| Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 100 kHz) | C _{ibo} | - | 60 | 80 | pF |
| Collector Base Time Constant (IC = 10 mAdc, V _{CB} = 10 Vdc, f = 4.0 MHz) | rb'C _C | _ | _ | 800 | ps |

⁽¹⁾ R_{6JA} is measured with the device soldered into a typical printed circuit board. (2) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

2N2368 2N2369,A 2N3227

2N2369A JAN, JTX, JTXV AVAILABLE CASE 22, STYLE 1 TO-18 (TO-206AA)

SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | | Symbol | Value | Unit |
|---|-----------------------|-----------------------------------|--------------|----------------|
| | 2368,9,A 3227 | VCEO | 15 20 | Vdc |
| Collector-Emitter Voltage | | VCES | 40 | Vdc |
| Collector-Base Voltage | | VCBO | 40 | Vdc |
| | 12368,9,A 13227 | VEBO | 4.5 6.0 | Vdc |
| Collector Current (10 µsec pulse) | | IC(Peak) | 500 | mA |
| | s 2369A, 3227 | ŀc | 200 | mA |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | | PD | 0.36 2.06 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C 2N | 13227 | PD | 1.2 6.85 | Watts mW/°C |
| Total Device Dissipation @ T _C = 100°C Derate above 100°C | | PD | .68 6.85 | Watts mW/°0 |
| Operating and Storage Junctio Temperature Range | n | T _J , T _{stg} | -65 to +200 | °C |

| Characteristic | | Symbol | Min | Max | Unit |
|---|---------------------------------------|-----------|----------------------|-------------------------|----------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, VBE = 0) | 2N3227 | V(BR)CEO | 20 | _ | Vdc |
| Collector-Emitter Breakdown Voltage (I _C = 10 μA, V _{BE} = 0) | | V(BR)CES | 40 | _ | Vdc |
| Collector-Emitter Sustaining Voltage(1) (IC = 10 mAdc, IB = 0) | 2N2368, 2N2369, 2N2369A | VCEO(sus) | 15 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 μA, IB = 0) | | V(BR)CBO | 40 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _E = 0) | 2N2368, 2N2369, 2N2369A 2N3227 | V(BR)EBO | 4.5 6.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 20 Vdc, VBE = 3.0 Vdc) | 2N3227 | ICEX | | 0.2 | μAdc |
| Collector Cutoff Current (VCB = 20 Vdc, I _E = 0) | 2N2368, 2N2369 2N3227 | Ісво | = | 0.4 0.2 | μAdc |
| $(V_{CB} = 20 \text{ Vdc}, l_E = 0, T_A = 150^{\circ}C)$ | 2N2368, 2N2369, 2N2369A 2N3227 | | _ | 30 50 | |
| Collector Cutoff Current (VCE = 20 Vdc, VBE = 0) | 2N2369A | ICES | | 0.4 | μAdc |
| Base Current (VCE = 20 Vdc, VBE = 0) | 2N2369A | IB | _ | 0.4 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(1) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) | 2N2368 2N2369 2N2369A 2N3227 | hFE | 20 40 — 100 | 60 120 120 300 | - |
| (I _C = 10 mAdc, V _{CE} = 1.0 Vdc, T _A = -55°C) | 2N2368 2N2369 2N3227 | | 10 20 40 | = | |
| $(I_C = 10 \text{ mAdc}, V_{CE} = 0.35 \text{ Vdc}, T_A = -55^{\circ}C)$ $(I_C = 30 \text{ mAdc}, V_{CE} = 0.4 \text{ Vdc})$ | 2N2369A 2N2369A | | 20 30 | _ | |

2N2368, 2N2369,A, 2N3227

| Characteristic | | | Symbol | Min | Max | Unit |
|--|---|-----------------------------|------------------|----------------------|---------------------------|------|
| , G | 2N2369A 2N3227 | | | 20 30 | _ | |
| | 2N2368 2N2369 | | | 10 20 | _ | |
| Collector-Emitter Saturation Voltage(1) | | | VCE(sat) | | | Vdc |
| | 2N2368, 2N23 2N2369A | 869, 2N3227 | | = | 0.25 0.20 | |
| | 2N2369A 2N2369A | | | _ | 0.30 0.25 | |
| | 2N2369A 2N3227 | | | _ | 0.50 .45 | |
| (IC = 10 mAdc, IB = 1.0 mAdc, T _A = +125°C) (IC = 10 mAdc, I _B = 1.0 mAdc, T _A = -55°C) (IC = 30 mAdc, I _B = 3.0 mAdc) | All Types 2N2369A 2N2369A 2N2369A 2N2369A | | VBE(sat) | 0.70 0.59 | 0.85 — 1.02 1.15 | Vdc |
| | 2Ņ3227 | | | 0.8 | 1.4 | |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| | 2N2368 2N2369, 2N23 | 169A, 2N3227 | fτ | 400 500 | _ | MHz |
| Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 140 kHz) | All Types | | C _{obo} | | 4.0 | pF |
| Input Capacitance (VBE = 1.0 Vdc, I _C = 0, f = 140 kHz) | 2N3227 | | C _{ibo} | _ | 4.0 | pF |
| SWITCHING CHARACTERISTICS | | | | | | |
| Delay Time (V _{CC} = 10 V, V _{EB} = 2.0 V | Vdc, | | t _d | _ | 5.0 | ns |
| Rise Time 100 mA, IB1 = 10 mA) | | 2N3227 | tr | _ | 18 | ns |
| Storage Time (IC = I _{B1} = 10 mAdc, I _{B2} = -10 mAdc) (IC = 100 mAdc, I _{B1} = I _{B2} = 10 mAdc, V _{CC} = 10 | V) | 2N2368 2N2369A 2N3227 | t _s | <u>-</u> | 10 13 13 | ns |
| Fall Time (V _{CC} = 10 V, I _C = 100 mA, I _{B1} = I _{B2} = 10 mA) | | 2N3227 | tf | _ | 15 | ns |
| Turn-On Time (IC = 10 mAdc, IB1 = 3.0 mA, IB2 = -1.5 mA, VC | C = 3.0 Vdc) | All Types | ton | | 12 | ns |
| Turn-Off Time $\{I_C = 10 \text{ mAdc, } I_{B1} = 3.0 \text{ mA, } I_{B2} = -1.5 \text{ mA, } V_C \}$ | | | ^t off | | - - 15 18 | ns |
| Total Control Charge (IC = 10 mA, IB = 1.0 mA, VCC = 3.0 V) | | 2N3227 | O _T | _ | 50 | рС |

FIGURE 1 — t_{on} CIRCUIT — 10 mA +10.6 V — t₁ — 3 V — 270 Ω -1.5 V — < 1 ns PULSE WIDTH (1) = 300 ns .DUTY CYCLE = 2%

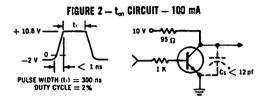
FIGURE 3 — t_{off} CIRCUIT — 10 mA

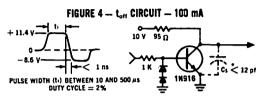
+10.75 v — t — 3 v — 270 Ω

-9.15 v — - 1 ms

PULSE WIDTH (1) = 300 ms

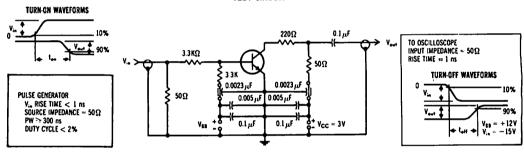
DUTY CYCLE = 2%

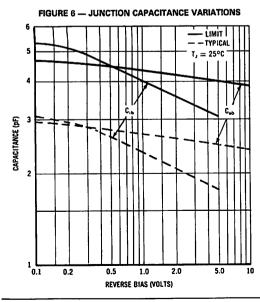


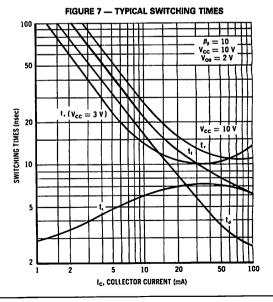


*Total shunt capacitance of test jig and connectors.

FIGURE 5 — TURN-ON AND TURN-OFF TIME TEST CIRCUIT







2N2368, 2N2369,A, 2N3227

FIGURE 8 — MAXIMUM CHARGE DATA 500 $V_{cc} = 10 \text{ V}$ - -100°C -25°C $Q_1, \beta_1 = 10$ 200 Q_r , $\beta_s = 40$ 100 CHARGE (pc) 20 10 10 20 50 100 Ic, COLLECTOR CURRENT (mA)

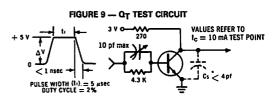


FIGURE 10 — TURN-OFF WAVE FORM

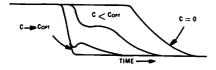
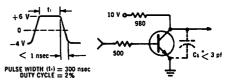
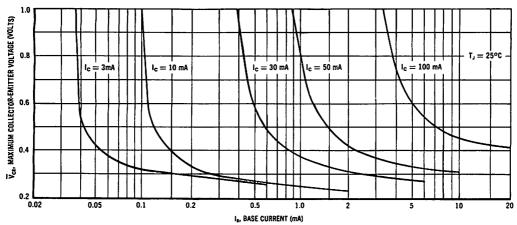
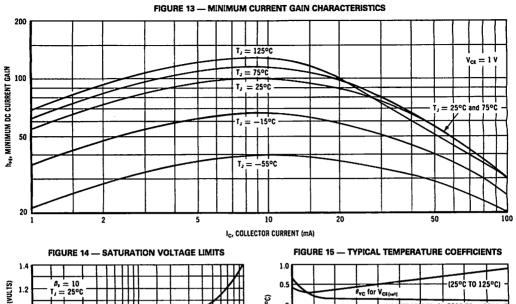


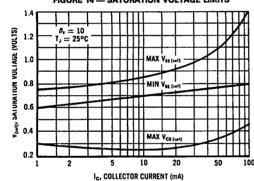
FIGURE 11 — STORAGE TIME EQUIVALENT TEST CIRCUIT

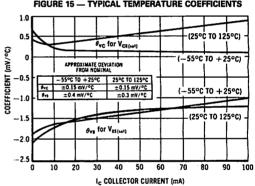












JAN, JTX AVAILABLE CASE 22, STYLE 1 TO-18 (TO-206AA)

SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

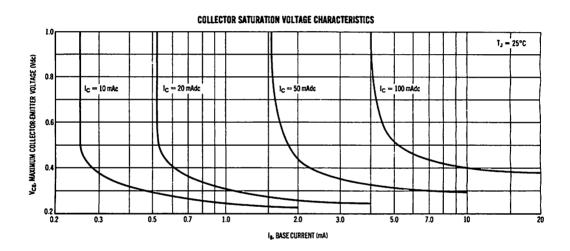
| Rating | Symbol | Value | Unit | | | |
|---|-----------------------------------|--------------|--------------|--|--|--|
| Collector-Emitter Voltage | VCEO | 15 | Vdc | | | |
| Collector-Base Voltage | VCBO | 40 | Vdc | | | |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.36 2.06 | Watt mW/℃ | | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 6.9 | Watts | | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C | | | |

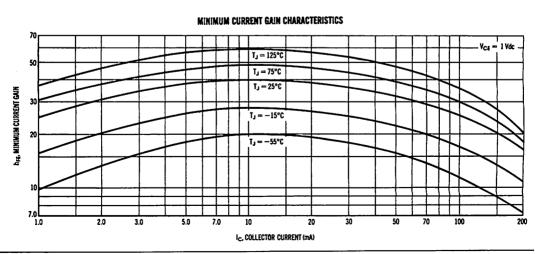
| Characteristic | Symbol | Min | Max | Unit |
|---|----------------------|----------------------|--------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 30 mAdc, Ig = 0) | V(BR)CEO | 15 | _ | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 1.0 µAdc, VBE = 0) | V(BR)CES | 30 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 μAdc, IE = 0) | V(BR)CBO | 40 | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 20 Vdc, VBE = 3.0 Vdc) (VCE = 20 Vdc, VBE = 3.0 Vdc, TA = 150°C) | ^I CEX | _ | 0.05 15 | μAdc |
| Emitter Cutoff Current (VEB = 4.0 Vdc, I _C = 0) | I _{EBO} | _ | 100 | nAdc |
| Base Cutoff Current (VCE = 20 Vdc, VBE = 3.0 Vdc) | IBL | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | 1 |
| DC Current Gain (IC = 1.0 mAdc, V _{CE} = 1.0 Vdc) (IC = 10 mAdc, V _{CE} = 1.0 Vdc) (IC = 10 mAdc, V _{CE} = 1.0 Vdc, T _A = -55°C)(1) (IC = 150 mAdc, V _{CE} = 1.0 Vdc)(1) | hFE | 25 40 20 20 | 120 — | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) (IC = 100 mAdc, Ig = 10 mAdc)(1) | VCE(sat) | = | 0.25 0.40 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) (IC = 100 mAdc, Ig = 10 mAdc)(1) | VBE(sat) | 0.7 | 0.82 1.25 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Output Capacitance (V _{CB} = 5.0 V, I _C = 0, f = 1.0 MHz) | C _{obo} | _ | 5.0 | pF |
| Input Capacitance (VEB = 0.5 V, f = 1.0 MHz) | C _{ibo} | | 7.0 | pF |
| Small-Signal Current Gain (VCE = 10 V, IC = 10 mA, f = 100 MHz) | h _{fe} | 3.0 | _ | _ |
| Real Part of input impedance (IC = 10 mA, VCE = 10 V, f = 250 MHz) | Re(h _{ie}) | _ | 60 | Ohms |

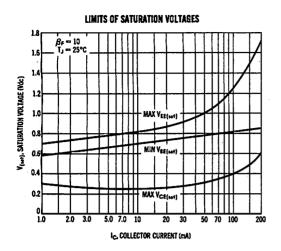
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

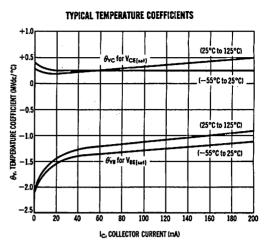
| Characteristic | Symbol | Min | Max | Unit |
|---|----------------|-----|----------|------|
| SWITCHING CHARACTERISTICS | | | | |
| Storage Time (I _C = 10 mA, I _{B1} = 10 mA, I _{B2} = 10 mA) | t _s | _ | 20 | ns |
| Turn-On Time (I _C = 100 mA, I _{B1} = 10 mA, $V_{BE(off)}$ = 2.0 V) (I _C = 10 mA, I _{B1} = 1.0 mA, $V_{BE(off)}$ = 2.0 V) | ton | _ | 40 75 | ns |
| Turn-Off Time (I _C = 100 mA, I _{B1} = 10 mA, I _{B2} = 5.0 mA) (I _C = 10 mA, I _{B1} = 1.0 mA, I _{B2} = 0.5 mA) | toff | | 55 45 | ns |

⁽¹⁾ Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

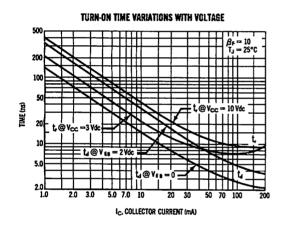


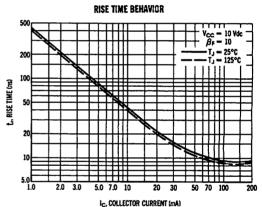


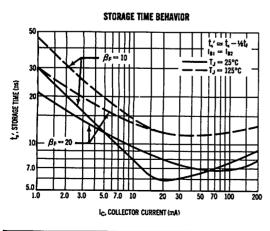


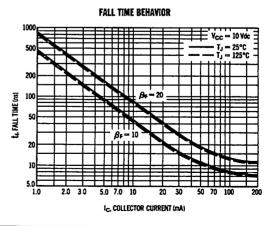


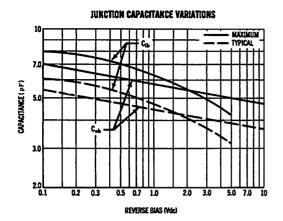
TYPICAL SWITCHING CHARACTERISTICS

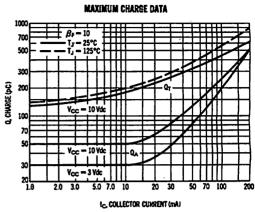












MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 60 | Vdc |
| Collector-Base Voltage | VCBO | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | Vdc |
| Collector Current — Continuous | lc | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 360 2.06 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 6.85 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|--|------------------|-----|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 146 | °C/W |
| Thermal Resistance, Junction to Ambient | ROJA(1) | 485 | °C/W |
| Lead Temperature 1/16" from Case for 10 Seconds | TL | 300 | °C |

2N2484

JAN, JTX, JTXV AVAILABLE **CASE 22-03, STYLE 1** TO-18 (TO-206AA)

AMPLIFIER TRANSISTOR

NPN SILICON

| Refer to | 2N2481 fe | or graphs. |
|----------|-----------|------------|
|----------|-----------|------------|

| ELECTRICAL CHARACTERISTICS (T _A = 25°C unless otherwise noted.) | neier to 2142481 for graphs. | | | | |
|--|------------------------------|--------------------------------------|--|------------------------|--------------|
| Characteristic | Symbol | Min | Тур | Max | Unit |
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (I _C = 10 mAdc, I _B = 0) | V(BR)CEO | 60 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | V(BR)CBO | 60 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 μAdc, IC = 0) | V(BR)EBO | 6.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 45 Vdc, I_E = 0) (VCB = 45 Vdc, I_E = 0, T_A = 150°C) | ICBO | 1 1 | | 10 10 | nAdc µAdc |
| Emitter Cutoff Current (VBE = 5.0 Vdc, IC = 0) | IEBO | _ | _ | 10 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain ($I_C = 1.0 \mu A dc$, $V_{CE} = 5.0 V dc$) ($I_C = 10 \mu A dc$, $V_{CE} = 5.0 V dc$) ($I_C = 10 \mu A dc$, $V_{CE} = 5.0 V dc$, $I_A = 55^{\circ}C$) ($I_C = 100 \mu A dc$, $V_{CE} = 5.0 V dc$) ($I_C = 500 \mu A dc$, $V_{CE} = 5.0 V dc$) ($I_C = 1.0 m A dc$, $V_{CE} = 5.0 V dc$) ($I_C = 10 m A dc$, $V_{CE} = 5.0 V dc$) ($I_C = 10 m A dc$, $V_{CE} = 5.0 V dc$)($I_C = 10 m A dc$, $I_C = 5.0 V dc$) | ptE | 30 100 20 175 200 250 | 190 250 40 275 300 350 400 | 500 800 | |
| Collector-Emitter Saturation Voltage (I _C = 1.0 mAdc, I _B = 0.1 mAdc) | V _{CE(sat)} | _ | 0.25 | 0.35 | Vdc |
| Base-Emitter On Voltage (I _C = 0.1 mAdc, V _{CE} = 5.0 Vdc) | V _{BE(on)} | 0.5 | 0.65 | 0.7 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | • |
| Current-Gain — Bandwidth Product $(I_C=0.05 \text{ mAdc}, V_{CE}=5.0 \text{ Vdc}, f=5.0 \text{ MHz})$ $(I_C=0.5 \text{ mAdc}, V_{CE}=5.0 \text{ Vdc}, f=30 \text{ MHz})$ | ÍΤ | 15 60 | 50 100 | _ | MHz |
| Output Capacitance (VCB = 5.0 Vdc, IE = 0, f = 140 kHz) | Cobo | _ | 3.0 | 6.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = 0, f = 140 kHz) | Cibo | | 4.0 | 6.0 | pF |
| Input Impedance (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | hie | 3.5 | | 24 | kΩ |
| Voltage Feedback Ratio (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | h _{re} | _ | _ | 800 | X 10-6 |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz | h _{fe} | 150 | _ | 900 | - |
| Output Admittance (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | hoe | _ | _ | 40 | μmhos |
| Noise Figure (I _C = 10 μ Adc, V _{CE} = 5.0 Vdc, R _S = 10 k Ω , f = 100 Hz, BW = 20 Hz) (I _C = 10 μ Adc, V _{CE} = 5.0 Vdc, R _S = 10 k Ω , | NF | _ | 8.0 | 10 | dB |
| f = 1.0 kHz, BW = 200 Hz) (IC = 10 μ Adc, V _{CE} = 5.0 Vdc, R _S = 10 kΩ, | | _ | - | 3.0 | |
| f = 10 kHz, BW = 2.0 kHz) (IC = 10 μAdc, V _{CE} = 5.0 Vdc, R _S = 10 kΩ, f = 10 Hz to 15.7 kHz, BW = 15.7 kHz) | | _ _ | _ | 2.0 3.0 | |
| 11 D is measured with the decise and and the second of the decise of the second of | L | | | | L |

⁽¹⁾ R_{6JA} is measured with the device soldered into a typical printed circuit board. (2) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

CASE 22, STYLE 1 TO-18 (TO-206AA)

SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

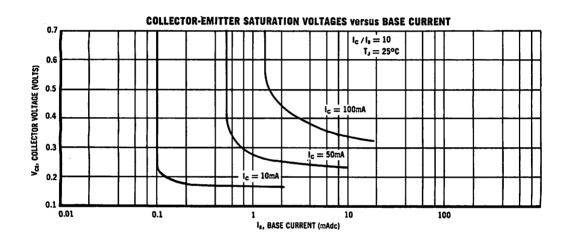
| THE AUTOM TEATHER | | | |
|---|-----------------------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Base Voltage | V _{CBO} | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | Vdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.36 2.1 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 6.9 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

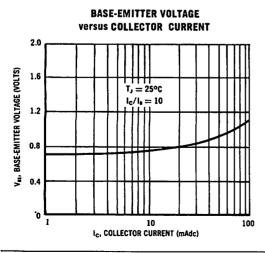
| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|----------------------------------|------------------------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 30 mAdc, IB = 0, Pulsed) | V(BR)CEO | 20 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | V(BR)CBO | 40 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | V(BR)EBO | 6.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 20 Vdc, VBE = 3.0 Vdc) | ICEX | 1 | 25 | nAdc |
| Base Cutoff Current (VCE = 20 Vdc, VBE = 3.0 Vdc) (VCE = 20 Vdc, VBE = 3.0 Vdc, TA = 150°C) | 1 _{BL} | . = | 0.025 50 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 100 µAdc, V _{CE} = 1.0 Vdc) (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc, T _A = -55°C) (I _C = 50 mAdc, V _{CE} = 1.0 Vdc) (I _C = 100 mAdc, V _{CE} = 1.0 Vdc) (I _C = 500 mAdc, V _{CE} = 5.0 Vdc) | ptE | 20 30 50 20 40 30 | 150 — — — — — | _ |
| Collector-Emitter Saturation Voltage(1) (IC = 10 mAdc, Ig = 1.0 mAdc) (IC = 50 mAdc, Ig = 5.0 mAdc) (IC = 100 mAdc, Ig = 10 mAdc) | VCE(sat) | _ _ _ | 0.2 0.3 0.4 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc) (I _C = 100 mAdc, I _B = 10 mAdc) | VBE(sat) | <u>-</u> | 0.85 1.0 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (VCE = 20 Vdc, I _C = 10 mAdc, f = 100 MHz) | fr | 350 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | _ | 4.0 | ρF |
| Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 100 kHz) | C _{ibo} | _ | 7.0 | pF |
| Small-Signal Current Gain (VCE = 20 Vdc, IC = 10 mAdc, f = 100 MHz) | h _{fe} | 3.5 | _ | _ |

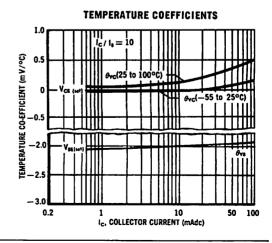
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|---|----------------|-----|-----|------|
| SWITCHING CHARACTERISTICS | | | | |
| Charge Storage Time Constant (I _C = I _{B1} = I _{B2} = 10 mAdc) | τS | _ | 15 | ns |
| Total Control Charge (IC = 10 mAdc, IB = 1.0 mAdc) | Q _t | - | 60 | pC |
| Active Region Time Constant (IC = 10 mAdc) | τΑ | _ | 2.5 | ns |

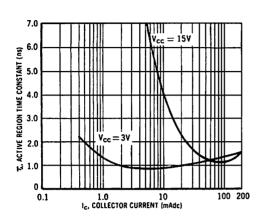
⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.



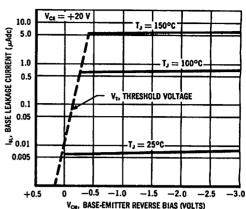




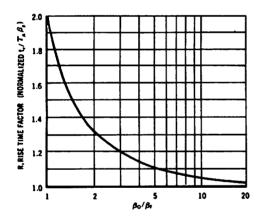
ACTIVE REGION TIME CONSTANT



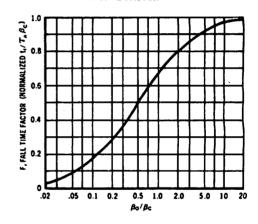
COMMON EMITTER DC LEAKAGE CHARACTERISTICS



RISE TIME FACTOR



FALL TIME FACTOR



CASE 22, STYLE 1 TO-18

SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 30 | Vdc |
| Collector-Emitter Voltage | VCER \ | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.5 2.86 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.8 10.3 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|--|------------------|----------------------|---------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 100 mAdc, pulsed, IB = 0) | V(BR)CEO | 30 | _ | Vdc |
| Collector-Emitter Breakdown Voltage (I _C = 100 mAdc, pulsed, R _{BE} ≤ 10 Ω) | V(BR)CER | 40 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | V(BR)CBO | 60 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | V(BR)EBO | 5.0 | - | Vdc |
| Collector Cutoff Current (VBE = 0.2 Vdc, VCE = 20 Vdc) | ICEX | _ | 0.250 | μAdc |
| Collector Cutoff Current ($V_{CB} = 40 \text{ Vdc}$, $I_E = 0$) ($V_{CB} = 40 \text{ Vdc}$, $I_E = 0$, $T_A = 150^{\circ}\text{C}$) | СВО | | 0.250 200 | μAdc |
| Emitter Cutoff Current (VEB = 3.0 Vdc, IC = 0) | IEBO | _ | 0.05 | μAdc |
| Base Cutoff Current (VBE = 0.2 Vdc, VCE = 20 Vdc) (VBE = 0.2 Vdc, VCE = 20 Vdc, TA = 150°C) | IBL | _ | 0.250 200 | μAdc |
| ON CHARACTERISTICS(1) | | | | |
| DC Forward Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) 2N2539 (I _C = 10 mAdc, V _{CE} = 10 Vdc) 2N2539 (I _C = 150 mAdc, V _{CE} = 10 Vdc)(1) 2N2539 (I _C = 500 mAdc, V _{CE} = 10 Vdc)(1) 2N2539 | pŁE | 20 30 50 20 | - 150 - | _ |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | Cobo | 1 | 8.0 | pF |
| Input Capacitance (VEB = 0.5 Vdc, IC = 0, f = 100 kHz) | C _{ibo} | | 25 | pF |
| Small-Signal Current Gain (VCE = 20 Vdc, IC = 20 mAdc, f = 100 MHz) | h _{fe} | 2.5 | _ | _ |
| SWITCHING CHARACTERISTICS | | | | |
| Storage Time (I _C = I _{B1} = I _{B2} = 20 mAdc, V _{CC} = 5.0 V) | rs | | 20 | ns |
| Active Region Time Constant | ₹A | 1 | 2.0 | ns |
| Turn-On Time (I _{B1} = I _{B2} = 15 mAdc, I _C = 150 mAdc, V_{CC} = 7.0 Vdc, R_L = 40 Ω) | ton | _ | 40 | ns |
| Turn-Off Time (IB1 = IB2 = 15 mAdc, IC = 150 mAdc, VCC = 7.0 Vdc, RL = 40 Ω) | ^t off | - | 40 | ns |
| Total Control Charge | Ω_{τ} | _ | 750 | рС |

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

JAN, JTX AVAILABLE **CASE 26-03, STYLE 1** TO-46 (TO-206AB)

AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|-------------|
| Collector-Emitter Voltage | VCEO | 45 | ٧ |
| Collector-Base Voltage | VCBO | 60 | V |
| Emitter-Base Voltage | VEBO | 6 | ٧ |
| Collector Current — Continuous | İC | 30 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 400 2.28 | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | ;•C |

Refer to 2N3962 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|----------------------|-----------------------|----------------------|-------------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) IC = 10 mA (Pulse) | V _{(BR)CEO} | 45 | _ | V |
| Collector-Base Breakdown Voltage (I _C = 10 μA) | V(BR)CBO | 60 | | v |
| Emitter-Base Breakdown Voltage (I _E = 10 μA) | V(BR)EBO | 6 | _ | ٧ |
| Collector Cutoff Current (VCB = 45 V) | Ісво | _ | 10 | nA |
| Base-Emitter Short Circuit Current (VCE = 45 V) (VCE = 45 V, TA = 170°C) | ICES | = | 10 10 | nA μA |
| Emitter Cutoff Current (VBE = 5.0 V) | IEBO | _ | 2 | nA |
| ON CHARACTERISTICS | | | | |
| DC Current Gain(1) ($V_{CE} = 5.0 \text{ V}$, $I_{C} = 10 \mu\text{A}$) ($V_{CE} = 5.0 \text{ V}$, $I_{C} = 500 \mu\text{A}$) ($V_{CE} = 5.0 \text{ V}$, $I_{C} = 10 \text{ mA}$) ($V_{CE} = 5.0 \text{ V}$, $I_{C} = 10 \mu\text{A}$, $T_{A} = -55^{\circ}\text{C}$) | hFE | 100 150 — 20 | 300 — 600 — | _ _ _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mA, I _B = 500 μA) | V _{CE(sat)} | | 0.5 | V |
| Base-Emitter Saturation Voltage (IC = 10 mA, IB = 500 μA) | V _{BE(sat)} | 0.7 | 0.9 | V |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Output Capacitance (VCB = 5.0 V, IE = 0, f = 1.0 MHz) | Cobo | _ | 6 | pF |
| input impedance (VCE = 5.0 V, IC = 1.0 mA, f = 100 MHz) | hie | _ | 200 | Ω |
| Input Impedance (VCB = 5.0 V, IE = 1.0 mA, f = 1.0 kHz) | hib | 25 | 35 | Ω |
| Voltage Feedback Ratio (VCB = 5.0 V, IE = 1.0 mA, f = 1.0 kHz) | hrb | _ | 10 | 10-4 |
| Small-Signal Current Gain (V _{CB} = 5.0 V, \pm = 1.0 mA, f = 1.0 kHz) (V _{CB} = 5.0 V, \pm = 5.0 \pm A, f = 30 MHz) | h _{fe} | 150 1.0 | 600 | _ |
| Output Admittance (VCB = 5.0 V, IE = 1.0 mA, f = 1.0 kHz) | h _{ob} | _ | 1 | μmho |
| Noise Figure(2) (V _{CB} = 5.0 V, I _C = 10 μ A, R _g = 10 k Ω , BW = 15.7 kHz) | NF | _ | 3 | dB |

Pulse Width < 300 μsec, Duty Cycle ≤ 2.0%.
 Measured in amplifier with response down 3 db at 10 Hz.

CASE 79, STYLE 1 TO-39 (TO-205AD)

SWITCHING TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|--------------|----------------|
| Collector-Emitter Voltage | VCEO | 35 | Vdc |
| Collector-Base Voltage | V _{CBO} | 50 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 800 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.8 4.57 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 3.0 17.14 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

Refer to 2N2904 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|----------------------|------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 100 mAdc, I _B = 0) | VCEO(sus) | 35 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 50 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | V(BR)EBO | 5.0 | - | Vdc |
| Collector Cutoff Current (VCE = 25 Vdc, VBE = 0.5 Vdc Off) | ICEX | | 100 | nAdc |
| Base Cutoff Current (VCE = 25 Vdc, VBE = 0.5 Vdc Off) | IBL | | 100 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain ($I_C = 0.1 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$) ($I_C = 150 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$)($I_C = 150 \text{ mAdc}$, $V_{CE} = 1.0 \text{ Vdc}$)($I_C = 500 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$)($I_C = 500 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$)($I_C = 500 \text{ mAdc}$) | hfE | 20 30 15 25 | 90 | _ |
| Collector-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) (IC = 500 mAdc, IB = 50 mAdc) | V _{CE(sat)} | _ | 0.4 1.2 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc) (I _C = 500 mAdc, I _B = 50 mAdc) | V _{BE(sat)} | _ | 1.3 1.8 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (I _C = 50 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | fΤ | 120 | _ | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, f = 100 kHz) | C _{obo} | _ | 25 | pF |
| SWITCHING CHARACTERISTICS | | | | |
| Delay Time | ^t d | 9 | 25 | ns |
| Rise Time | t _r | 25 | 45 | ns |
| Storage Time | ts | 100 | 225 | ns |
| Fall Time | tf | 30 | 45 | ns |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

CASE 22, STYLE 1 TO-18 (TO-206AA)

SWITCHING TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| MAXIMUM KATINGS | | | |
|--|----------------------|--------------|-------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage(1) | VCEO | 12 | Vdc |
| Collector-Base Voltage | VCBO | 12 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | Ic | 200 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 360 2.06 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1200 6.85 | mW mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | °C |

Refer to 2N889A for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|-----------------------|----------------------|--------------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 10 µAdc, VBE = 0) | V(BR)CES | 12 | - | Vdc |
| Collector-Emitter Sustaining Voltage(2) (IC = 10 mAdc, IB = 0) | V _{CEO(sus)} | 12 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 12 | _ | Vdc |
| Emitter-Base Breakdown Voltage (Ig = 100 µAdc, IC = 0) | V(BR)EBO | 4.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 6.0 Vdc, IE = 0, TA = 125°C) | ICBO | _ | 10 | μAdc |
| Collector Cutoff Current (VCE = 6.0 Vdc, VBE = 0) | ICES | | 80 | nAdc |
| Base Current (VCE = 6.0 Vdc, VBE = 0) | l8 | _ | 80 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain(2) (IC = 10 mAdc, VCE = 0.3 Vdc) (IC = 30 mAdc, VCE = 0.5 Vdc) (IC = 30 mAdc, VCE = 0.5 Vdc, TA = -55°C) (IC = 100 mAdc, VCE = 1.0 Vdc)(2) | hFE | 30 40 17 25 | _ 150 _ _ | _ |
| Collector-Emitter Saturation Voltage(2) (IC = 10 mAdc, Ig = 1.0 mAdc) (IC = 30 mAdc, Ig = 3.0 mAdc) (IC = 100 mAdc, Ig = 10 mAdc) | VCE(sat) | - - | 0.15 0.2 0.5 | Vdc |
| Bese-Emitter Saturation Voltage(2) (IC = 10 mAdc, Ig = 1.0 mAdc) (IC = 30 mAdc, Ig = 3.0 mAdc) (IC = 100 mAdc, Ig = 10 mAdc) | VBE(sat) | 0.78 0.85 — | 0.98 1.2 1.7 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 30 mAdc, VCE = 10 Vdc, f = 100 MHz) | fΤ | 400 | | MHz |
| Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 140 kHz) | C _{obo} | | 6.0 | pF |
| Input Capacitance (VBE = -0.5 Vdc, IC = 0, f = 140 kHz) | C _{ibo} | _ | 6.0 | pF |
| SWITCHING CHARACTERISTICS | | | | |
| Turn-On Time (V _{CC} = 2.0 Vdc, V _{BE} = 3.0 Vdc, I _C = 30 mAdc, I _{B1} = 1.5 mAdc) | ton | _ | 60 | ns |
| Turn-Off Time (V _{CC} = 2.0 Vdc, I _C = 30 mAdc, I _{B1} = I _{B2} = 1.5 mAdc) | toff | - | 90 | ns |

⁽¹⁾ Applicable from 0.01 to 10 mAdc.

⁽²⁾ Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2.0%.

MAXIMUM RATINGS

| WAXIMUW HATINGS | | | | | |
|--|----------------------|-------------|-------------|--------|----------------|
| Rating | Symbol | 2N2895 | 2N2896 | 2N2897 | Unit |
| Collector-Emitter Voltage | VCEO | 65 | 90 | 45 | Vdc |
| Collector-Emitter Voltage | VCER | 80 | 140 | 60 | Vdc |
| Collector-Base Voltage | V _{CBO} | 120 | 140 | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 7.0 | | | Vdc |
| Collector Current — Continuous | lc | 1.0 | | | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | | 0.5 2.86 | | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.8 10.3 | | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | - | °C | | |

2N2895 2N2896 2N2897

CASE 22, STYLE 1 TO-18 (TO-206AA)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

| ELECTRICAL | CHARACTERISTICS | (T _A = | : 25°C unless otherwise n | oted.) |
|------------|------------------------|-------------------|---------------------------|--------|
| | , | | | |

| Characteristic | | Symbol | Min | Max | Unit |
|--|--|-----------|----------------------------|-----------------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (I _C = 100 mAdc, R _{BE} = 10 ohms) | 2N2895 2N2896 2N2897 | V(BR)CER | 80 140 60 | _ | Vdc |
| Collector-Emitter Sustaining Voltage(1) (IC = 100 mAdc, IB = 0) | 2N2895 2N2896 2N2897 | VCEO(sus) | 65 90 45 | = | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.1 mAdc, IE = 0) | 2N2895 2N2896 2N2897 | V(BR)CBO | 120 140 60 | = | Vdc |
| Emitter-Base Breakdown Voltage (IE = 0.1 mAdc, IC = 0) | | V(BR)EBO | 7.0 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 60 Vdc, I _C = 0) | 2N2895 2N2896 2N2897 | ІСВО | | 0.002 0.01 0.05 | μAdc |
| $(V_{CB} = 60 \text{ Vdc}, l_{E} = 0, T_{A} = +150^{\circ}\text{C})$ | 2N2895 2N2897 | | _ | 2.0 50 | |
| (VCB = 90 Vdc, IE = 0) (VCB = 90 Vdc, IE = 0, TA = +150°C) | 2N2896 2N2896 | | | 0.01 10 | |
| Emitter Cutoff Current (VBE = 5.0 Vdc, I _C = 0) | 2N2895 2N2896 2N2897 | lEBO | - - | 0.005 0.01 0.05 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 10 μAdc, V _{CE} = 10 Vdc) (IC = 100 μAdc, V _{CE} = 10 Vdc) (IC = 1.0 mAdc, V _{CE} = 10 Vdc) (IC = 10 mAdc, V _{CE} = 10 Vdc) (IC = 10 mAdc, V _{CE} = 10 Vdc, T _A = -55°C) | 2N2895 2N2895 2N2896, 2N2897 2N2895 2N2895, 2N2896 | hFE | 10 20 35 35 20 | | - |
| (I _C = 150 mAdc, V _{CE} = 10 Vdc)(1) | 2N2895 2N2896 2N2897 | | 40 60 50 | 120 200 200 | |
| (I _C = 500 mAdc, V _{CE} = 10 Vdc)(1) | 2N2895 | | 25 | _ | |

2N2895, 2N2896, 2N2897

| Characteristic | | Symbol | Min | Max | Unit |
|---|--------------------------|----------------------|--------------|------------|------|
| Collector-Emitter Saturation Voltage(1) (IC = 150 mAdc, I _B = 15 mAdc) | 2N2895, 2N2896 2N2897 | VCE(sat) | - | 0.6 1.0 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 150 mAdc, I _B = 15 mAdc) | 2N2895, 2N2896 2N2897 | V _{BE(sat)} | _ | 1.2 1.3 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | • | • |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, V _{CE} = 10 Vdc, f = 20 MHz) | 2N2895, 2N2896 2N2897 | fT | 120 100 | = | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 100 kHz) | | C _{obo} | _ | 15 | p₽ |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 100 kHz) | | C _{ibo} | _ | 80 | pF |
| Small-Signal Current Gain (I _C = 5.0 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 kHz) | 2N2895 2N2896, 2N2897 | h _{fe} | 50 50 | 200 275 | _ |
| Noise Figure (I _C = 0.3 mAdc, V_{CE} = 10 Vdc, R_S = 500 ohms, f = 1.0 kHz, BW = 15 kHz) | 2N2895 | NF | _ | 8.0 | dB |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 1.8%.

MAXIMUM RATINGS

| Rating | Symbol | Non-A Suffix A-Suffix | | Non-A Suffix | | Non-A Suffix | | Non-A Suffix | | Non-A Suffix A-Su | | Unit |
|--|----------------------|-----------------------|-------------|--------------|----------------------|----------------|--|--------------|--|-------------------|--|------|
| Collector-Emitter Voltage | VCEO | 40 | | | 60 | Vdc | | | | | | |
| Collector-Base Voltage | VCBO | | 60 | | | Vdc | | | | | | |
| Emitter-Base Voltage | VEBO | | 5.0 | | | Vdc | | | | | | |
| Collector Current — Continuous | Ic | | mAdc | | | | | | | | | |
| | | 2N2904,A 2N2905,A | | | 2N3485,A 2N3486,A | | | | | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 600 3.43 | 400 2.28 | | 400 2.28 | mW mW/°C | | | | | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 3.0 17.2 | 1.8 10.3 | | 2.0 11.43 | Watts mW/°C | | | | | | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | | | | °C | | | | | | |

2N2904,A, 2N2905,A, 2N2906,A, 2N2907,A, 2N3485,A, 2N3486,A

JAN, JTX, JTXV AVAILABLE*

CASE 79-02, STYLE 1 2N2904/2905 TO-39 (TO-205AD) CASE 22-03, STYLE 1 2N2906/2907 TO-18 (TO-206AA) CASE 26-03, STYLE 1 2N3485/3486 TO-46 (TO-206AB)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characte | ristic | Symbol | Min | Тур | Max | Unit |
|---|--|----------|-----------------------|-------------|----------------|------|
| OFF CHARACTERISTICS | | | | | | _ |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, Ig = 0) | Non-A Suffix A-Suffix | V(BR)CEO | 40 60 | = | - | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | , | V(BR)CBO | 60 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | - | _ | Vdc |
| Collector Cutoff Current (VCE = 30 Vdc, VBE = 0.5 Vdc) | | CEX | | _ | 50 | nAdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) | Non-A Suffix A-Suffix | СВО | = | = | 0.020 0.010 | μAdc |
| (V _{CB} = 50 Vdc, l _E = 0, T _A = 150°C) | Non-A Suffix A-Suffix | | = | _ | 20 10 | |
| Base Current (VCE = 30 Vdc, VBE = 0.5 Vdc) | | IB | - | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain (I _C = 0.1 mAdc, V _{CE} = 10 Vdc) | 2N2904, 2N2906, 2N3485 2N2905, 2N2907, 2N3486 2N2904A, 2N2906A, 2N3485A 2N2905A, 2N2907A, 2N3486A | hFE | 20 35 40 75 | = | = | _ |
| (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) | 2N2904, 2N2906, 2N3485 2N2905, 2N2907, 2N3486 2N2904A, 2N2906A, 2N3485A 2N2905A, 2N2907A, 2N3486A | | 25 50 40 100 | - - - | | |
| (I _C = 10 mAdc, V _{CE} = 10 Vdc) | 2N2904, 2N2906, 2N3485 2N2905, 2N2907, 2N3486 2N2904A, 2N2906A, 2N3485A 2N2905A, 2N2907A, 2N3486A | | 35 75 40 100 | _ _ _ | - | |
| (IC = 150 mAdc, VCE = 10 Vdc)(1) | 2N2904A, 2N2906A, 2N3485,A 2N2905A, 2N2907A, 2N3486A | | 40 100 | _ | 120 300 | |

*ALSO AVAILABLE 2N2905ALJANS AND 2N2907AJANS

2N2904,A, 2N2905,A, 2N2906,A, 2N2907,A, 2N3485,A, 2N3486,A

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| ristic | Symbol | Min | Тур | Max | Unit |
|---------------------------|---|---|--|---|--|
| 2N2904, 2N2906, 2N3485 | | 20 | _ | _ | |
| 2N2905, 2N2907, 2N3486 | 1 | 30 | - | _ | 1 |
| 2N2904A, 2N2906A, 2N3485A | | 40 | _ | _ | |
| 2N2905A, 2N2907A, 2N3486A | 1. | 50 | _ | _ | |
| | VCE(sat) | | | | Vdc |
| | 1 | | - | 0.4 | 1 |
| <u> </u> | 1 | _ | _ | 1.6 | |
| | V _{BE(sat)} | | | | Vdc |
| | | _ | | 1.3 | l . |
| · | | | _ | 2.6 | |
| | 2N2904, 2N2906, 2N3485 2N2905, 2N2907, 2N3486 2N2904A, 2N2906A, 2N3485A | 2N2904, 2N2906, 2N3485 2N2905, 2N2907, 2N3486 2N2904A, 2N2906A, 2N3485A | 2N2904, 2N2906, 2N3485 20 2N2905, 2N2907, 2N3486 30 2N2904A, 2N2906A, 2N3485A 40 2N2905A, 2N2907A, 2N3486A 50 VCE(sat) ——————————————————————————————————— | 2N2904, 2N2906, 2N3485 20 — 2N2905, 2N2907, 2N3486 30 — 2N2904A, 2N2906A, 2N3485A 40 — 2N2905A, 2N2907A, 2N3486A 50 — VCE(sat) — — | 2N2904, 2N2906, 2N3486 2N2905, 2N2907, 2N3486 2N2904A, 2N2906A, 2N3485A 2N2905A, 2N2907A, 2N3486A 2N2905A, 2N2907A, 2N3486A 2N2905A, 2N2907A, 2N3486A 2N2905A, 2N2907A, 2N3486A 2VCE(sat) |

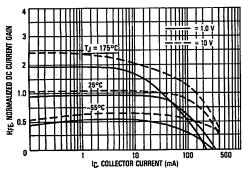
| Current-Gain — Bandwidth Product(2) (I _C = 50 mAdc, V _{CE} = 20 Vdc, f = 100 MHz) | fτ | 200 | - | - | MHz |
|--|------------------|-----|---|-----|-----|
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | _ | _ | 8.0 | pF |
| Input Capacitance (VBE = 2.0 Vdc, IC = 0, f = 100 kHz) | C _{ibo} | _ | - | 30 | pF |

SWITCHING CHARACTERISTICS

| Turn-On Time | | ton | — . | 26 | 45 | กร |
|---------------|--|----------------|------------|-----|-----|----|
| Delay Time | (V _{CC} = 30 Vdc, I _C = 150 mAdc, I _{B1} = 15 mAdc) | ^t d | | 6.0 | 10 | ns |
| Rise Time | - ISI - 13 III/de/ | tr | | 20 | 40 | ns |
| Turn-Off Time | | toff | _ | 70 | 100 | ns |
| Storage Time | (V _{CC} = 6.0 Vdc, I _C = 150 mAdc, I _{B1} = I _{B2} = 15 mAdc) | ts | _ | 50 | 80 | ns |
| Fall Time | - 181 - 182 - 13 III/00) | tf | _ | 20 | 30 | ns |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0.%

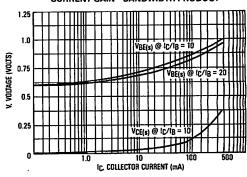
NORMALIZED DC CURRENT GAIN



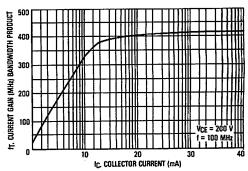
"ON" VOLTAGES CAPACITANCE (pF)

REVERSE VOLTAGE (VOLTS)

CURRENT GAIN—BANDWIDTH PRODUCT

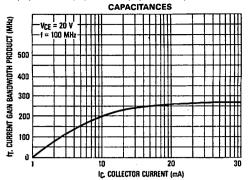


CURRENT GAIN—BANDWIDTH PRODUCT

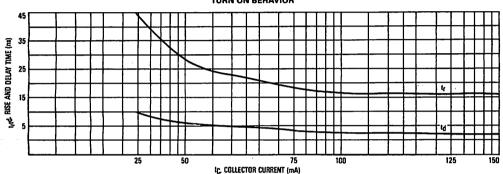


⁽²⁾ fT is defined as the frequency at which $|\mathbf{h}_{\text{fe}}|$ extrapolates to unity.

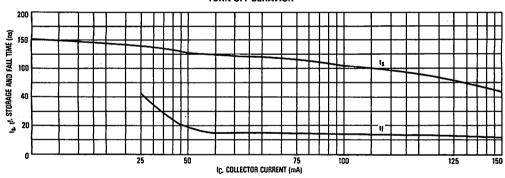
2N2904,A, 2N2905,A, 2N2906,A, 2N2907,A, 2N3485,A, 2N3486,A

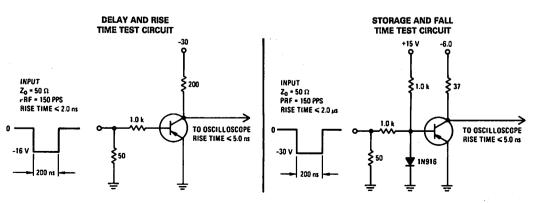


TURN ON BEHAVIOR



TURN OFF BEHAVIOR





2N2944 thru 2N2946

CASE 26-03, STYLE 1 TO-46 (TO-206AB)

TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | 2N2944 | 2N2945 | 2N2946 | Unit |
|--|----------------------|--------|----------------|--------|------|
| Emitter-Collector Voltage | VECO | 10 | 20 | 35 | Vdc |
| Collector-Base Voltage | VCBO | 15 | 25 | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 15 | 25 | 40 | Vdc |
| Collector Current — Continuous | lc | 100 | | | mAdc |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | | mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | | Watts mW/°C | | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | - | ℃ | | |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|-------------------|------|------|
| Thermal Resistance, Junction to Case | R _Ø JC | 87.5 | °C/W |
| Thermal Resistance, Junction to Ambient | RAJA | 435 | °C/W |

Refer to 2N2944A for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|--------|----------------------|----------|----------|-----|------|
| OFF CHARACTERISTICS | | - | | | | |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) | 2N2944 | ІСВО | _ | - I | 0.1 | nAdc |
| (VCB = 25 Vdc, IE = 0) | 2N2945 | | _ | - | 0.2 | |
| (V _{CB} = 40 Vdc, I _E = 0) | 2N2946 | | | | 0.5 | |
| Emitter Cutoff Current (VEB = 15 Vdc, IC = 0) | 2N2944 | IEBO | - | - | 0.1 | nAdc |
| (VEB = 25 Vdc, IC = 0) | 2N2945 | | l — | - | 0.2 | |
| (VEB = 40 Vdc, IC = 0) | 2N2946 | | <u> </u> | | 0.5 | Ĺ |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain | | hFE | | | | - |
| (IC = 1.0 mAdc, VCE = 0.5 Vdc) | 2N2944 | | 80 | 180 | - | |
| | 2N2945 | | 40 | 160 | - | |
| | 2N2946 | _ | 30 | 130 | | |
| *DC Current Gain (inverted connection) | | hFE(inv) | | | | - |
| (IB = 200 µAdc, VEC = 0.5 Vdc) | 2N2944 | į | 6.0 | 20 | _ | |
| | 2N2945 | | 4.0 | 17 15 | - | |
| <u> </u> | 2N2946 | | 3.0 | 15 | | ļ |
| Offset Voltage | | V _{EC(ofs)} | | | | mVdc |
| $(l_{B} = 200 \ \mu Adc, l_{E} = 0)$ | 2N2944 | | i – | 0.18 | 0.3 | |
| | 2N2945 | | - | 0.23 | 0.5 | i |
| | 2N2946 | 1 | _ | 0.27 | 0.8 | |
| (lg = 1.0 mAdc, lg = 0) | 2N2944 | | _ | 0.4 | 0.6 | Ì |
| #B | 2N2945 | | l — | 0.5 | 1.0 | ì |
| | 2N2946 | | - | 0.6 | 2.0 | 1 |
| (Ig = 2.0 mAdc, Ig = 0) | 2N2944 | 1 | _ | 0.8 | 1.0 | Ì |
| (IB = 2.0 mAdc, IE = 0) | 2N2945 | | 1 — | 0.9 | 1.6 | |
| | 2N2946 | | - | 1.0 | 2.5 | |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product | | fŢ | | | | MHz |
| (IC = 1.0 mAdc, VCE = 6.0 Vdc, f = 1.0 MHz) | 2N2944 | | 10 | 15 | _ | l ' |
| | 2N2945 | | 5.0 | 13 | _ | |
| | 2N2946 | | 3.0 | 12 | | |
| Output Capacitance (VCB = 6.0 Vdc, IE = 0, f = 500 kHz) | | Cobo | _ | 3.2 | 10 | pF |
| Input Capacitance (VEB = 6.0 Vdc, IC = 0, f = 500 kHz) | | C _{ibo} | _ | 1.9 | 6.0 | pF |
| "ON" Series Resistance | | rec | ĺ | | | Ohms |
| $(I_B = 1.0 \text{ mAdc}, I_E = 0, I_C = 100 \mu Arms, f = 1.0 \text{ kHz})$ | 2N2944 | 1 | - | 4.0 | 20 | |
| | 2N2945 | 1 | - | 4.5 | 35 | |
| | 2N2946 | | | 5.0 | 45 | L |

*Indicates Data in addition to JEDEC Requirements.

MAXIMUM RATINGS

| MAXIMUM RATINGS | | | | | |
|--|----------------------|-------------|----------------|---------|------|
| Rating | Symbol | 2N2944A | 2N2945A | 2N2946A | Unit |
| Emitter-Collector Voltage | VECO | 10 | 20 | 35 | Vdc |
| Collector-Base Voltage | VCBO | 15 | 25 | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 15 | 25 | 40 | Vdc |
| Collector Current — Continuous | l _C | | | mAdc | |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | | mW mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | | Watts mW/°C | | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | | | °C |
| Lead Temperature 1/16" from Case for 10 seconds | TL | 240 | | | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|-------------------|------|------|
| Thermal Resistance, Junction to Case | R _Ø JC | 435 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 87.5 | °C/W |

2N2944A 2N2945A 2N2946A

JAN, JTX, JTXV AVAILABLE CASE 26-03, STYLE 1 TO-46 (TO-205AB)

CHOPPER TRANSISTOR

PNP SILICON

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|--|----------|-----------------|--------------------|-------------------|-------------|
| OFF CHARACTERISTICS | | | | • | L | |
| Emitter-Collector Breakdown Voltage (IE = 10 μ Adc, IB = 0) | 2N2944A 2N2945A 2N2946A | V(BR)ECO | 10 20 35 | | | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) (VCB = 25 Vdc, IE = 0) | 2N2944A 2N2945A | СВО | _ | = | 0.1 0.2 | nAdc |
| (VCB = 40 Vdc, IE = 0) (VCB = 15 Vdc, IE = 0, TA = 100°C) (VCB = 25 Vdc, IE = 0, TA = 100°C) (VCB = 40 Vdc, IE = 0, TA = 100°C) | 2N2946A 2N2944A 2N2945A 2N2946A | | _ | _ | 0.5 10 20 | |
| Emitter Cutoff Current (VEB = 25 Vdc, IC = 0) | 2N2944A 2N2945A | lEBO | | | 0.1 0.2 | nAdc |
| (V _{EB} = 40 Vdc, I _C = 0) (V _{EB} = 25 Vdc, I _C = 0, T _A = 100°C) | 2N2946A 2N2944A 2N2945A | | _ _ _ | _ _ _ | 0.5 10 15 | |
| (V _{EB} = 40 Vdc, I _C = 0, T _A = 100°C) ON CHARACTERISTICS | 2N2946A | | | <u> </u> | 20 | |
| DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 0.5 Vdc) | 2N2944A 2N2945A 2N2946A | hFE | 100 70 50 | 200 200 | = | _ |
| DC Current Gain (Inverted Connection) (I _B = 200 μAdc, V _{EC} = 0.5 Vdc) | 2N2944A 2N2945A 2N2946A | hFE(inv) | 50 30 20 | | | - |
| Offset Voltage (lg = 200 μAdc, lg = 0) | 2N2944A 2N2945A 2N2946A | VEC(ofs) | _ _ _ | 0.23 0.4 0.7 | 0.3 0.5 0.8 | mVdc |

2N2944A, 2N2945A, 2N2946A

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Charac | teristic | Symbol | Min | Тур | Max | Unit |
|-------------------------|----------|--------|----------|-----|-----|------|
| (IB = 1.0 mAdc, IE = 0) | 2N2944A | , | _ | _ | 0.6 | |
| (18 - 10 113 tas) 1E sy | 2N2945A | | _ | 0.5 | 1.0 | |
| | 2N2946A | | _ | 0.6 | 2.0 | l |
| (lg = 2.0 mAdc, tg = 0) | 2N2944A | | _ | _ | 1.0 | l |
| 1 | 2N2945A | | — | 0.9 | 1.6 | l . |
| | 2N2946A | | - | 1.0 | 2.5 | |

SMALL-SIGNAL CHARACTERISTICS

| Current-Gain — Bandwidth Product | | fT | | | | MHz |
|---|---------|------------------|-----|----------|-----|----------|
| (IC = 1.0 mAdc, VCE = 6.0 Vdc, f = 1.0 MHz) | 2N2944A | | | – | l – | l |
| , | 2N2945A | i | 10 | 15 | l – | , |
| , | 2N2946A | | 5.0 | 8.0 | _ | |
| Output Capacitance (VCB = 6.0 Vdc, I _E = 0, f = 0.1 MHz to 1.0 MHz) | | C _{obo} | | 3.2 | 10 | pF |
| Input Capacitance (VEB = 6.0 Vdc, IC = 0, f = 0.1 MHz to 1.0 MHz) | | C _{ibo} | _ | 1.9 | 6.0 | pF |
| "ON" Series Resistance | | rec(on) | 1 | | | Ohms |
| $(l_B = 1.0 \text{ mAdc}, l_E = 0, l_e = 100 \mu\text{Arms}, f = 1.0 \text{kHz})$ | 2N2944A | l i | - | ! — | 4.0 | 1 |
| | 2N2945A | 1 | 1 - | 5.0 | 6.0 | 1 |
| | 2N2946A | | | 7.0 | 8.0 | 1 |

1.0 Vac 1.0 kHz 1.0 kHz 0UTPUT



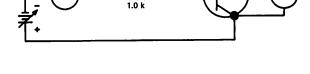
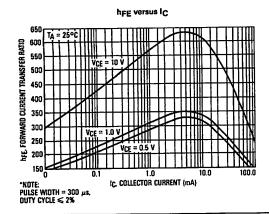
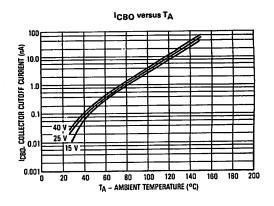


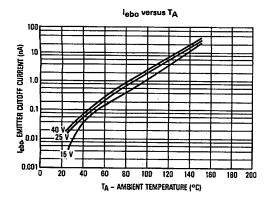
FIGURE 2 — VEC(offset)

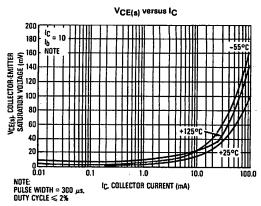
10 k 2% Output Figure 1 — rec(on) rec(on) rec(on) mA 1.0k 2% V
Output measured with H.P. 400D
Ac VTVM or equivalent.
1.0 mV = 1.0 Ω rec(on)

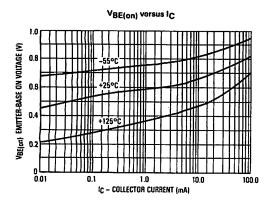


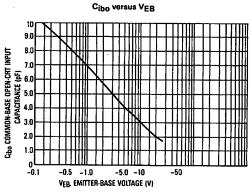


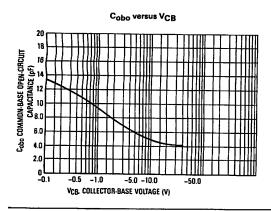
2N2944A, 2N2945A, 2N2946A

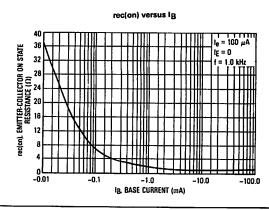


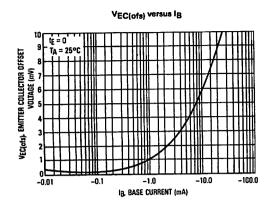


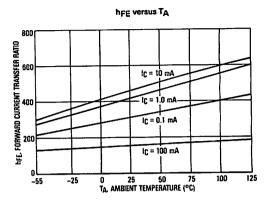


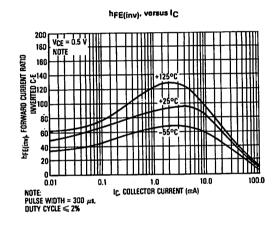












CASE 79, STYLE 1 TO-39 (TO-205AD) SWITCHING TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Base Voltage | VCBO | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 600 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 3.0 20 | Watts mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 0.6 4.00 | Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|--|-----------------------|-----|-------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 10 mAdc, pulsed, Ig = 0) | V(BR)CEO | 20 | | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 µAdc, I _E = 0) | V _(BR) CBO | 60 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | V _{(BR)EBO} | 5.0 | - | Vdc |
| Collector Cutoff Current (VCE = 30 Vdc, VBE = 0.5 Vdc) | ^I CEX | _ | .050 | μAdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) (VCB = 50 Vdc, IE = 0, TA = 150°C) | ІСВО | = | 0.025 15 | μAdc |
| Base Cutoff Current (VCE = 30 Vdc, VBE = 0.5 Vdc) | I _{BL} | _ | .050 | μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 150 mAdc, V _{CE} = 10 Vdc) | hFE | 100 | 300 | |
| Collector-Emitter Saturation Voltage(1) (IC = 150 mAdc, IB = 15 mAdc) | V _{CE(sat)} | _ | 0.5 | Vdc |
| Base-Emitter Saturation Voltage(1) (I _C = 150 mAdc, I _B = 15 mAdc) | V _{BE(sat)} | _ | 1.3 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | · |
| Current-Gain — Bandwidth Product (IC = 20 mA, V_{CE} = 20 V, f = 100 MHz) | fT | 250 | _ | MHz |
| Output Capacitance (VCB = 10 V, I _E = 0, f = 100 kHz) | C _{obo} | _ | 8.0 | pF |
| SWITCHING CHARACTERISTICS | | | | |
| Delay Time (V _{CC} = 30 V, I _{CS} = 150 mA, I _{B1} = 15 mA) | td | _ | 20 | ns |
| Rise Time (VCC = 30 V, I _{CS} = 150 mA, I _{B1} = 15 mA) | t _r | _ | 75 | ns |
| Storage Time (V _{CC} = 6.0 V, I _{CS} = 150 mA, I _{B1} = 15 mA, I _{B2} = 15 mA) | ts | _ | 300 | ns |
| Fall Time (V _{CC} = 6.0 V, I _{CS} = 150 mA, I _{B1} = 15 mA, I _{B2} = 15 mA) | tf | _ | 200 | ns |
| 1) Bules Test, Bules Wilds, a con. | | | | |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

CASE 22, STYLE 1 TO-18 (TO-206AA)

SWITCHING TRANSISTOR

NPN SILICON

MAXIMI IM RATINGS

| MAXIMUM KATINGS | | | |
|---|-----------------------------------|----------------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage(1) | VCEO | 12 | Vdc |
| Collector-Emitter Voltage | VCES | 30 | Vdc |
| Collector-Base Voltage | V _{CBO} | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous Peak (10 µs Pulse) | lc | 200 500 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.36 2.06 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C T _C = 100°C Derate above 25°C | PD | 1.20 0.68 6.85 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | င |

Refer to 2N2368 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|----------------------|----------------|------------------------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, IB = 0) | V(BR)CEO | 12 | | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 10 µAdc, VBE = 0) | V(BR)CES | 30 | | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | V(BR)CBO | 30 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | V(BR)EBO | 5.0 | | Vdc |
| Collector Cutoff Current (VCE = 20 Vdc VBE = 0) (VCE = 20 Vdc, VBE = 0, TA = +85°C) | ICES | | 0.4 10 | μAdc |
| Base Cutoff Current (VCE = 20 Vdc, VBE = 0) | IBL | | 0.4 | μAdc |
| ON CHARACTERISTICS (2) | | | | |
| DC Current Gain (IC = 10 mAdc, VCE = 0.35 Vdc) (IC = 30 mAdc, VCE = 0.4 Vdc) (IC = 100 mAdc, VCE = 1.0 Vdc) | hFE | 30 25 12 | 120 — — | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 30 mAdc, IB = 3.0 mAdc) (IC = 100 mAdc, IB = 10 mAdc) (IC = 100 mAdc, IB = 1.0 mAdc, TA = +85°C) | VCE(sat) | | 0.20 0.25 0.50 0.30 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 30 mAdc, I _B = 3.0 mAdc) (I _C = 100 mAdc, I _B = 10 mAdc) | V _{BE(sat)} | 0.72 — — | 0.87 1.15 1.60 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | ., |
| Current-Gain — Bandwidth Product (IC = 20 mAdc, VCE = 10 Vdc, f = 100 MHz) | fT | 400 | | MHz |
| Output Capacitance (VCB = 5.0 Vdc, IE = 0, f = 140 kHz) | Cobo | <u></u> | 4.0 | pF |
| SWITCHING CHARACTERISTICS | | | | |
| Storage Time (IC = IB1 = -IB2 = 10 mAdc) | ts | | 13 | ns |
| Turn-On Time (V _{CC} = 2.0 Vdc, V _{EB(off)} = 0, I _C = 30 mAdc, I _{B1} = 3.0 mAdc) | ton | _ | 15 | ns |
| Turn-Off Time (V _{CC} = 2.0 Vdc, I_C = 30 mAdc, I_{B1} = $-I_{B2}$ = 3.0 mAdc) | toff | | 20 | ns |

⁽¹⁾ Applicable from 0.01 mA to 10 mA (Pulsed). (2) Pulse Test: Pulse Length = 30 μ s, Duty Cycle \leq 2.0%.

MAXIMIM PATINGS

| MAXIMUM HATINGS | | | |
|---|----------------------|--------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 12 | Vdc |
| Collector-Base Voltage | VCBO | 12 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | lc | 200 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.36 2.06 | Watts mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 6.85 | Watts mW/°C |
| Operating and Storage Junction | TJ, T _{stg} | -65 to +200 | °C |

2N3012

CASE 22-03, STYLE 1 TO-18 (TO-206AA)

SWITCHING TRANSISTOR

PNP SILICON

Refer to 2N869A for graphs.

| Cheracteristic | Symbol | Min | Max | Unit |
|---|------------------|----------------|---------------------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 10 μAdc, V _{BE} = 0) | V(BR)CES | 12 | _ | Vdc |
| Collector-Emitter Sustaining Voltage(1) (I _C = 10 mAdc, I _B = 0) (Emitter-Base Termination — Open Base) | VCEO(sus) | 12 | | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | V(BR)CBO | 12 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | V(BR)EBO | 4.0 | _ | Vdc |
| Collector Cutoff Current ($V_{CE} = 6.0 \text{ Vdc}$, $V_{BE} = 0$) ($V_{CE} = 6.0 \text{ Vdc}$, $V_{BE} = 0$, $T_{A} = +85^{\circ}\text{C}$) | ICES | = | 80 5.0 | μAdc |
| Base Current (VCE = 6.0 Vdc, VBE = 0) | t _B | _ | 30 | μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 10 mAdc, V _{CE} = 0.3 Vdc) (IC = 30 mAdc, V _{CE} = 0.5 Vdc) (IC = 100 mAdc, V _{CE} = 1.0 Vdc)(1) | phE | 25 30 20 | 120 | _ |
| Collector-Emitter Saturation Voltage(1) (IC = 10 mAdc, IB = 3.0 mAdc) (IC = 30 mAdc, IB = 3.0 mAdc, TA = +85°C) (IC = 30 mAdc, IB = 10 mAdc) | VCE(sat) | <u>-</u> | 0.15 0.2 0.4 0.5 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 10 mAdc, Ig = 1.0 mAdc) (IC = 30 mAdc, Ig = 3.0 mAdc) (IC = 100 mAdc, Ig = 10 mAdc) | VBE(sat) | 0.78 0.85 | 0.98 1.2 1.7 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Output Cepacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 140 kHz) | Cobo | _ | 6.0 | pF |
| Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 140 kHz) | C _{ibo} | - | 6.0 | pF |
| Small-Signal Current Gain (IC = 30 mAdc, V_{CE} = 10 Vdc, f = 100 MHz) | hfe | 4.0 | _ | - |
| SWITCHING CHARACTERISTICS | | | | |
| Turn-On Time (V _{CC} = 2.0 Vdc, I _C ~30 mAdc, I _{B1} ~1.5 mAdc) | ton | | 60 | ns |
| Turn-Off Time (V _{CC} = 2.0 Vdc, I _C ~30 mAdc, I _{B1} = I _{B2} ~1.5 mAdc) | toff | | 75 | ns |

⁽¹⁾ Pulse Test: Pulse Width = 300 µs, Duty Cycle = 1.0%.

2N3013 2N3014

2N3013 JAN, JTX AVAILABLE CASE 27, STYLE 1 TO-52 (TO-206AC)

SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|----------------------|------------------------|
| Collector-Emitter Voltage(1) 2N3013 2N3014 | VCEO | 15 20 | Vdc |
| Collector-Emitter Voltage | VCES | 40 | Vdc |
| Collector-Base Voltage | VCBO | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous (10 µs pulse) Peak | lc | 200 500 | mAdc |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 0.36 2.06 | Watt mW/℃ |
| Total Device Dissipation @ T _C = 25°C @ T _C = 100°C Derate above 25°C | PD | 1.20 0.68 6.85 | Watts Watt mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | ဗ |

⁽¹⁾ Applicable from 0.01 mA to 10 mA (Pulsed)

Refer to 2N3510 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|--------------------------------------|------------------|----------------------------------|--|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 100 μAdc, V _{BE} = 0) | | V(BR)CES | 40 | _ | Vdc |
| Collector-Emitter Sustaining Voltage(2) (IC = 10 mAdc, IB = 0) | 2N3013 2N3014 | VCEO(sus) | 15 20 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0) | | V(BR)CBO | 40 | _ | Vdc |
| (IE = 100 μAdc, IC = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 20 Vdc, VBE = 0) (VCE = 20 Vdc, VBE = 0, TA = +125°C) | | ¹ CES | _ | 0.3 40 | μAdc |
| Base Current (VCE = 20 Vdc, VBE = 0) | | IB | _ | 0.3 | μAdc |
| ON CHARACTERISTICS(2) | | | | | |
| DC Current Gain (I _C = 30 mAdc, V _{CE} = 0.4 Vdc) (I _C = 100 mAdc, V _{CE} = 0.5 Vdc) (I _C = 100 mAdc, V _{CE} = 0.4 Vdc) (I _C = 300 mAdc, V _{CE} = 1.0 Vdc) (I _C = 100 mAdc, V _{CE} = 1.0 Vdc) (I _C = 30 mAdc, V _{CE} = 0.4 Vdc, T _A = -55°C) | 2N3013 2N3014 2N3013 2N3014 | hFE | 30 25 25 15 25 12 | 120 — — — — — | _ |
| Collector-Emitter Saturation Voltage (I _C = 30 mAdc, I _B = 3.0 mAdc) (I _C = 100 mAdc, I _B = 10 mAdc) (I _C = 100 mAdc, I _B = 10 mAdc) (I _C = 300 mAdc, I _B = 30 mAdc) (I _C = 10 mAdc, I _B = 3.0 mAdc) (I _C = 30 mAdc, I _B = 3.0 mAdc, T _A = +125°C) | 2N3013 2N3014 2N3013 2N3014 | VCE(sat) | 11111 | 0.18 0.28 0.35 0.50 0.18 0.25 | Vdc |
| Base-Emitter Saturation Voltage (IC = 30 mAdc, IB = 3.0 mAdc) (IC = 100 mAdc, IB = 10 mAdc) (IC = 300 mAdc, IB = 30 mAdc) (IC = 10 mAdc, IB = 1.0 mAdc) | 2N3013 2N3014 | VBE(sat) | 0.75 — — 0.70 | 0.95 1.20 1.70 0.80 | Vdc |

| Characteristic | Symbol | Min | Max | Unit |
|--|------------------|--------------|-----|------|
| SMALL-SIGNAL CHARACTERISTICS | • | | • | |
| Current-Gain — Bandwidth Product (IC = 30 mAdc, VCE = 10 Vdc, f = 100 MHz) | fT | 350 | - | MHz |
| Output Capacitance (VCB = 5.0 Vdc, I _E = 0, f = 140 kHz) | C _{obo} | - | 5.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 140 kHz) | Cibo | _ | 8.0 | pF |
| SWITCHING CHARACTERISTICS | | | | |
| Storage Time (IC = IB1 = IB2 = 10 mAdc) | t _S | _ | 18 | ns |
| Turn-On Time (VEB(off) = 5.0 V, V _{CC} = 15 V, I _C = 300 mAdc, I _{B1} = 30 mAdc) | ton | | | ns |
| 2N3013 (VEB(off) = 0, VCC = 2.0 V, I _C = 30 mAdc, I _{B1} = 3.0 mAdc) 2N3014 | | _ | 15 | |
| Turn-Off Time (V _{CC} = 15 V, I _C = .300 mAdc, I _{B1} = I _{B2} = 30 mAdc) 2N3013 | ^t off | | 25 | ns |
| $(V_{CC} = 2.0 \text{ V}, I_{C} = 30 \text{ mAdc}, I_{B1} = I_{B2} = 30 \text{ mAdc})$ 2N3013 | | _ | 25 | |

⁽²⁾ Pulse Test: Pulse Width = 300 µs, Duty Cycle ≤ 2.0%.

2N3019 2N3020 2N3700

JAN, JTX, JTXV AVAILABLE 2N3019, 2N3020 CASE 79-02, STYLE 1 TO-39 (TO-205AD)

GENERAL TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | 2N3019 2N3020 | 2N3700 | Unit |
|---|-----------------------------------|------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 80 | 80 | Vdc |
| Collector-Base Voltage | VCBO | 140 | 140 | Vdc |
| Emitter-Base Voltage | VEBO | 7.0 | 7.0 | Vdc |
| Collector Current — Continuous | l _C | 1.0 | 1.0 | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.8 4.6 | 0.5 2.85 | Watts mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | 1.8 10.6 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 65 to | +200 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | 2N3019 2N3020 | 2N3700 | Unit |
|---|--------|------------------|--------|------|
| Thermal Resistance, Junction to Case | ReJC | 16.5 | 70 | °C/W |
| Thermal Resistance, Junction to Ambient | RøJA | 89.5 | 245 | °C/W |

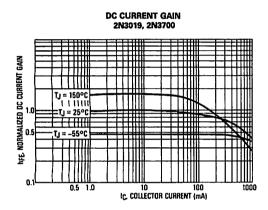
| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------------|----------------------|-----------|------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 30 mAdc, IB = 0) | | V(BR)CEO | 80 | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | | V(BR)CBO | 140 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 µAdc, IC = 0) | | V _{(BR)EBO} | 7.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 90 Vdc, IE = 0) (VCB = 90 Vdc, IE = 0, TA = +150°C) | | ICBO | | 0.01 10 | μAdc |
| Emitter Cutoff Current (VRF = 5.0 Vdc, IC = 0) | | IEBO | - | 0.010 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(1) (t _C = 0.1 mAdc, V _{CE} = 10 Vdc) | 2N3700, 2N3019 2N3020 | hFE | 50 30 | 100 | _ |
| $(I_C = 10 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})$ | 2N3700, 2N3019 2N3020 | | 90 40 | 120 | |
| (I _C = 150 mAdc, V _{CE} = 10 Vdc) | 2N3700, 2N3019 2N3020 | | 100 40 | 300 120 | |
| $(I_C = 150 \text{ mAdc}, V_{CE} = 10 \text{ Vdc}, T_C = -55^{\circ}C)$ | 2N3700, 2N3019 | | 40 | _ | |
| (I _C = 500 mAdc, V_{CE} = 10 Vdc) | 2N3700, 2N3019 2N3020 | | 50 30 | 100 | |
| (IC = 1.0 Adc, VCE = 10 Vdc) | All Types | | 15 | | |
| Collector-Emitter Saturation Voltage (Ic = 150 mAdc, Ig = 15 mAdc) (Ic = 500 mAdc, Ig = 50 mAdc) | | V _{CE(sat)} | 1 1 | 0.2 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) | | V _{BE(sat)} | _ | 1.1 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 10 Vdc, f = 20 MHz) | 2N3020 2N3019, 2N3700 | fT | 80 100 | 400 | MHz |

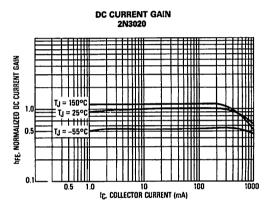
2N3019, 2N3020, 2N3700

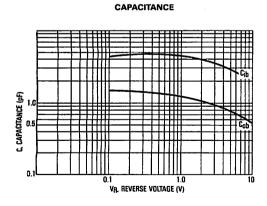
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

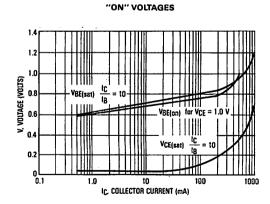
| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------------|-------------------|----------|------------|------|
| Output Capacitance (VCB = 10 Vdc, Ig = 0, f = 1.0 MHz) | | C _{obo} | - | 12 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | | C _{ibo} | - | 60 | pF |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | 2N3700, 2N3019 2N3020 | h _{fe} | 80 30 | 400 200 | _ |
| Collector Base Time Constant (IE = 10 mAdc, VCB = 10 Vdc, f = 4.0 MHz) | 2N3019, 2N3020 2N3700 | rb'C _C | 15 | 400 400 | ps |
| Noise Figure (IC = 100 μAdc, V _{CE} = 10 Vdc, R _S = 1.0 k ohms, f = 1.0 kHz) | 2N3019, 2N3700 | · NF | _ | 4 | dB |

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 1.0%.

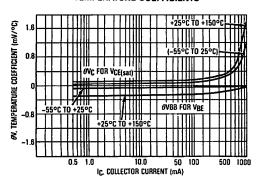




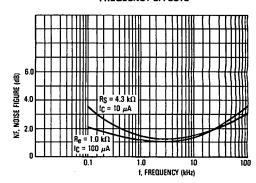






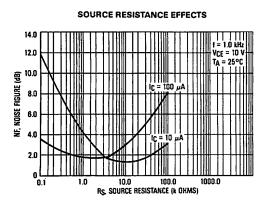


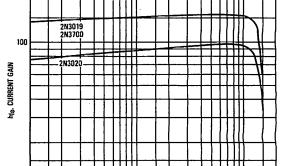
FREQUENCY EFFECTS



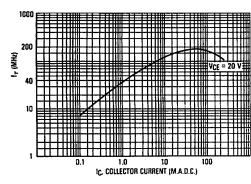
CURRENT GAIN BANDWIDTH PRODUCT versus COLLECTOR CURRENT — 1 kHz h_{fe}

0.1



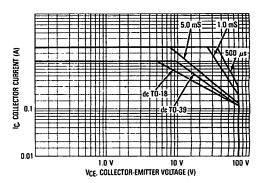


CURRENT GAIN — BANDWIDTH PRODUCT



ACTIVE REGION SAFE OPERATING AREA

IC COLLECTOR CURRENT (mA dc)



10

MAXIMUM RATINGS

| Rating | Symbol | 2N3053 | 2N3053A | Unit |
|--|-----------------------------------|-------------|---------|----------------|
| Collector-Emitter Voltage(1) | VCEO | 40 | 60 | Vdc |
| Collector-Base Voltage | VCBO | 60 | 80 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc |
| Collector Current — Continuous | lc | 700 | | mAdc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | ₽D | 5.0 28.6 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | °C |
| Lead Temperature 1/16", ± 1/32" From Case for 10 s | TL | + 235 | | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|--------------------------------------|------------------|-----|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 35 | °C/W |

⁽¹⁾ Applicable 0 to 100 mA (Pulsed):

Pulse Width ≤ 300 µsec., Duty Cycle ≤ 2.0%. 0 to 700 mA; Pulse Width ≤ 10 µsec., Duty Cycle ≤ 2.0%.

2N3053,A

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to 2N3019 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------|----------------------|--------------|------------|-------------|
| OFF CHARACTERISTICS | | | | • | |
| Collector-Emitter Breakdown Voltage(2) (I _C = 100 μAdc, I _B = 0) | 2N3053 2N3053A | V(BR)CEO | 40 60 | _ | Vdc |
| Collector-Emitter Breakdown Voltage(2) (I _C = 100 mAdc, R _{BE} = 10 ohms) | 2N3053 2N3053A | V(BR)CER | 50 70 | = | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μ Adc, IE = 0) | 2N3053 2N3053A | V(BR)CBO | 60 80 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | | Vdc |
| Collector Cutoff Current (VCE = 30 Vdc, VBE(off) = 1.5 Vdc) (VCE = 60 Vdc, VBE(off) = 1.5 Vdc) | 2N3053 2N3053A | ICEX | _ | 0.25 | μAdc |
| Emitter Cutoff Current (VBE = 4.0 Vdc, IC = 0) | 2N3053 | [[] EBO | _ | 0.25 | μAdc |
| Base Cutoff Current (VCE = 60 Vdc, VBE(off) = 1.5 Vdc) | 2N3053A | IBL | _ | 0.25 | μAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain (I _C = 150 mAdc, V _{CE} = 2.5 Vdc) (I _C = 150 mAdc, V _{CE} = 10 Vdc) | | hFE | 25 50 | 250 | _ |
| Collector-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) | 2N3053 2N3053A | VCE(sat) | - | 1.4 0.3 | Vdc |
| Base-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) | 2N3053 2N3053A | V _{BE(sat)} | 0.6 | 1.7 1.0 | Vdc |
| Base-Emitter On Voltage (IC = 150 mAdc, VCE = 2.5 Vdc) | 2N3053 2N3053A | V _{BE(on)} | _ | 1.7 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | • | |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 10 |) Vdc, f = 20 MHz) | fT | 100 | — | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 140 kHz) | | Cobo | _ | 15 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = 0, f = 140 kHz) | | C _{ibo} | _ | 80 | ρF |

(2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

2N3073 CASE 22-03, STYLE 1 TO-18 (TO-206AA)

SWITCHING TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| MAXIMUM KATINGS | | | |
|---|-----------------------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 60 | Vdc |
| Collector-Base Voltage | VCBO | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | íC | 500 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 360 2.06 | mW mW/℃ |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 6.85 | Watts mW/°C |
| Operating and Storage Junction | T _J , T _{stg} | -65 to +200 | °C |

Refer to 2N2904 for graphs.

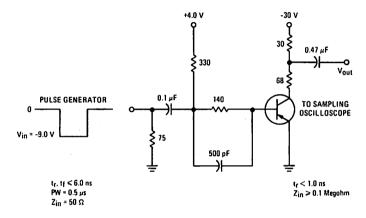
| Characteristic | Symbol | Min | Max | Unit |
|---|-----------------------|----------------|---------------|--------------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 30 mAdc, IB = 0) | V(BR)CEO | 60 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 60 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | V(BR)EBO | 4.0 | | Vdc |
| Collector Cutoff Current (VCE = 30 Vdc, VBE = 0) (VCE = 30 Vdc, VBE = 0, TA = 125°C) | ICES | <u>-</u> | 10 10 | nAdc μAdc |
| Emitter Cutoff Current (VEB = 4.0 Vdc, IC = 0) | ¹ EBO | | 100 | μAdc |
| Base Current (VCE = 30 Vdc, VBE = 0) | lΒ | _ | 10 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain(1) (I _C = 50 mAdc, V _{CE} = 1.0 Vdc) (I _C = 50 mAdc, V _{CE} = 1.0 Vdc, T _A = -55°C) (I _C = 300 mAdc, V _{CE} = 2.0 Vdc) | hFE | 30 12 15 | 130 — — | _ |
| Collector-Emitter Saturation Voltage (I _C = 50 mAdc, I _B = 2.5 mAdc) (I _C = 300 mAdc, I _B = 30 mAdc) | VCE(sat) | =_ | 0.25 1.0 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 50 mAdc, I _B = 2.5 mAdc) (I _C = 300 mAdc, I _B = 30 mAdc) | V _{BE} (sat) | _ | 1.2 2.0 | Vdc |
| Base-Emitter On Voltage (IC = 50 mAdc, VCE = 1.0 Vdc) | V _{BE(on)} | _ | 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product(2) (I _C = 50 mAdc, V _{CE} = 20 Vdc, f = 100 MHz) | fτ | 130 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 140 kHz) | C _{obo} | - | 10 | pF |
| Input Impedance (IC = 10 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{ie} | _ | 1.5 | kohms |
| Voltage Feedback Ratio (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{re} | _ | 26 | X 10-4 |
| Small Signal Current Gain (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{fe} | 25 | 180 | _ |
| Output Admittance (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{oe} | _ | 1200 | μmhos |

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|--|--------|-----|-----|------|
| SWITCHING CHARACTERISTICS | | | | |
| Turn-On Time (I _C ~300 mAdc, I _{B1} ~30 mAdc) | ton | _ | 40 | ns |
| Turn-Off Time (I _C ~300 mAdc, I _{B1} ~I _{B2} ~30 mAdc) | toff | - | 100 | ns |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 1.0%.

FIGURE 1 - TURN-ON AND TURN-OFF SWITCHING TIMES TEST CIRCUIT



⁽²⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.

CASE 79, STYLE 1 TO-39 (TO-205AD)

AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Machine In Indiana | | | |
|---|----------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage(1) | VCEO | 150 | Vdc |
| Collector-Base Voltage | VCBO | 150 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | İC | 200 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.8 4.57 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | °C |

Refer to 2N3498 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|----------------|-------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = = 30 mAdc, IB = 0) | V(BR)CEO | 150 | - | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 µAdc, I _E = 0) | V(BR)CBO | 150 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 µAdc, IC = 0) | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 100 Vdc, I _E = 0) (V _{CB} = 100 Vdc, I _E = 0, T _A = 150°C) | СВО | | 0.010 10 | μAdc |
| Emitter Cutoff Current (VEB = 4.0 Vdc, I _C = 0) | ¹ EBO | _ | 0.10 | μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain(2) (I _C = 0.1 mAdc, V _{CE} = 10 Vdc) (I _C = 30 mAdc, V _{CE} = 10 Vdc) (I _C = 30 mAdc, V _{CE} = 10 Vdc, T _A = -55°C) | hFE | 15 30 12 | 120 — | _ |
| Collector-Emitter Saturation Voltage(2) (IC = 50 mAdc, IB = 5.0 mAdc) | VCE(sat) | _ | 1.0 | Vdc |
| Base-Emitter Saturation Voltage(2) (I _C = 50 mAdc, I _B = 5.0 mAdc) | VBE(sat) | - | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Output Capacitance (VCB = 20 Vdc, IE = 0, f = 140 kHz) | C _{obo} | _ | 9.0 | pF |
| Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 140 kHz) | C _{ibo} | - | 80 | pF |
| Small-Signal Current Gain (IC = 1.0 mA, VCE = 5.0 V, f = 1 kHz) | h _{fe} | 25 | _ | _ |
| Current Gain — High Frequency (VCE = 10 Vdc, IC = 30 mAdc, f = 20 MHz) | [h _{fe}] | 2.0 | _ | |
| Real Part of Input Impedance (IC = 10 mA, VCE = 10 V, f = 100 MHz) | Re(h _{ie}) | _ | 30 | Ohms |

⁽¹⁾ Between 0 and 30 mA.

⁽²⁾ Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 1.0%.

CASE 79, STYLE 1 TO-39 (TO-205AD)

2N3135

CASE 22, STYLE 1 TO-18 (TO-206AA)

SWITCHING TRANSISTOR

PNP SILICON

Min

Symbol

Refer to 2N2904 for graphs.

Max

Unit

MAXIMUM RATINGS

| Rating | Symbol | 2N3133 | 2N3135 | Unit |
|---|----------------------|-------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 35 | 35 | Vdc |
| Collector-Base Voltage | V _{CBO} | 50 | 50 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | 4.0 | Vdc |
| Collector Current — Continuous | lc | 600 | 600 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.6 3.43 | 0.4 2.28 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 3 17.14 | 1.8 10.3 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | | °C |

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic

OFF CHARACTERISTICS Collector-Emitter Breakdown Voltage(1) V(BR)CEO 35 Vdc (IC = 10 mAdc, IB = 0) Collector-Base Breakdown Voltage Vdc V(BR)CBO 50 $(I_C = 10 \, \mu Adc, I_E = 0)$ Emitter-Base Breakdown Voltage V(BR)EBO 4.0 Vdc (lg = 10 μAdc, lc = 0) **Collector Cutoff Current** CEX μAdc $(V_{CE} = 30 \text{ V}, V_{BE} = 0.5 \text{ V})$ Collector Cutoff Current **"**Adc Ісво $(V_{CB} = 30 \text{ Vdc}, I_E = 0)$ 0.05 (VCB = 30 Vdc, IE = 0, TA = 150°C) 30 **Base Cutoff Current** 0.1 IBL μAdc $(V_{CE} = 30 \text{ V}, V_{BE} = 0.5 \text{ V})$ ON CHARACTERISTICS DC Current Gain hFE $(I_C = 1.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})$ 25 (IC = 150 mAdc, VCE = 10 Vdc)(1) 120 40 Collector-Emitter Saturation Voltage(1) V_{CE(sat)} 0.6 Vdc (IC = 150 mAdc, IB = 15 mAdc) Base-Emitter Saturation Voltage(1) 1.5 Vdc VBE(sat) (IC = 150 mAdc, IB = 15 mAdc) **SMALL-SIGNAL CHARACTERISTICS** Current-Gain - Bandwidth Product fτ 200 MHz (IC = 50 mAdc, VCE = 20 Vdc, f = 100 MHz) **Output Capacitance** C_{obo} 10 οF (VCB = 10 Vdc, IE = 0, f = 100 kHz) Input Capacitance Cibo 40 ρF $(V_{BE} = 2 \text{ Vdc}, I_{C} = 0, f = 100 \text{ kHz})$ SWITCHING CHARACTERISTICS Turn-On Time 26 75 ton ns

(V_{CC} = 6.0 V, I_C = 150 mA, I_{B1} = I_{B2} = 15 mA) (1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

 $(V_{CC} = 30 \text{ V, } I_{C} = 150 \text{ mA, } I_{B1} = 15 \text{ mA})$

150

ns

70

toff

2N3244 2N3245

CASE 79, STYLE 1 TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

2N3227

For Specifications, See 2N2368 Data.

MAXIMUM RATINGS

| Rating | Symbol | 2N3244 | 2N3245 | Unit |
|---|----------------------|-------------|--------|----------------|
| Collector-Emitter Voltage | VCEO | 40 | 50 | Vdc |
| Collector-Base Voltage | V _{CBO} | 40 | 50 | Vdc |
| Emitter-Base Voltage | VEBO | 5 | .0 | Vdc |
| Collector Current — Continuous | lc | 1.0 | | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.71 | | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|-------|-------|
| Thermal Resistance, Junction to Case | RøJC | 35 | °C⁄W |
| Thermal Resistance, Junction to Ambient | RAJA | 0.175 | °C/mW |

| Characteristic | | Symbol | Min | Max | Unit |
|--|------------------|----------|------------|--------------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | 2N3244 2N3245 | V(BR)CEO | . 40 50 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | 2N3244 2N3245 | V(BR)CBO | 40 50 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Base Cutoff Current (VCE = 30 Vdc, VBE = 3.0 Vdc) | | 1BEV | - | 80 | nAdc |
| Collector Cutoff Current (VCE = 30 Vdc, VBE = 3.0 Vdc) | | CEX | _ | 50 | nAdc |
| Collector Cutoff Current (V _{CB} = 30 Vdc, I _E = 0) (V _{CB} = 30 Vdc, I _E = 0, T _A = 100°C) | | ІСВО | _ | 0.0 5 0 10 | μAdc |
| Emitter Cutoff Current (VEB = 3.0 Vdc, IC = 0) (VEB = 4.0 Vdc, IC = 0) | 2N3245 2N3244 | IEBO | - | 30 30 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(1) (I _C = 150 mAdc, V _{CE} = 1.0 Vdc) | 2N3244 2N3245 | pte | 60 35 | = | _ |
| (IC = 500 mAdc, VCE = 1.0 Vdc) | 2N3244 2N3245 | | 50 30 | 150 90 | |
| (IC = 1.0 Adc, VCE = 5.0 Vdc) | 2N3244 2N3245 | | 25 20 | | |
| Collector-Emitter Saturation Voltage(1) (I _C = 150 mAdc, I _B = 15 mAdc) | 2N3244 2N3245 | VCE(sat) | = | 0.3 0.35 | Vdc |
| $(I_C = 500 \text{ mAdc}, I_B = 50 \text{ mAdc})$ | 2N3244 2N3245 | | = | 0.5 0.6 | |
| (I _C = 1.0 Adc, I _B = 100 mAdc) | 2N3244 2N3245 | | _ | 1.0 1.2 | |

2N3244, 2N3245

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| | Characteristic | | Symbol | Min | Max | Unit |
|--|---|------------------|------------------|--------------|-------------------|------|
| Base-Emitter Saturati (I _C = 150 mAdc, I _E (I _C = 500 mAdc, I _E (I _C = 1.0 Adc, I _B = | g = 15 mAdc) g = 50 mAdc) | | VBE(sat) | 0.75 | 1.1 1.5 2.0 | Vdc |
| SMALL-SIGNAL CHA | ARACTERISTICS | | | | | |
| Current-Gain — Band (I _C = 50 mAdc, V _C | Swidth Product E = 10 Vdc, f = 100 MHz) | 2N3244 2N3245 | f 1 | 175 150 | = | MHz |
| Output Capacitance (VCB = 10 Vdc, IE | = 0, f = 100 kHz} | | C _{obo} | _ | 25 | pF |
| Input Capacitance (VEB = 0.5 Vdc, IC | = 0, f = 100 kHz) | | C _{ibo} | | 100 | pF |
| SWITCHING CHARA | CTERISTICS | | | | | |
| Delay Time | # 500 A I 50 A | 2N3244 | ^t d | | 15 | ns |
| Rise Time | (I _C = 500 mA, I _{B1} = 50 mA V _{EB} = 2.0 V, V _{CC} = 30 V) | 2N3244 2N3245 | t _r | _ | 35 40 | ns |
| Storage Time | (IC = 500 mA, VCC = 30 V | 2N3244 | ts | _ | 140 120 | ns |
| Fall Time | l _{B1} = l _{B2} = 50 mA) | 2N3245 | tf | - | 45 | ns |
| Total Control Charge (IC = 500 mA, IB | = 50 mA, V _{CC} = 30 V) | 2N3244 2N3245 | Q _T | | 14 12 | pC |

⁽¹⁾ Pulse Test: PW ≤ 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 1 - MINIMUM CURRENT GAIN CHARACTERISTICS

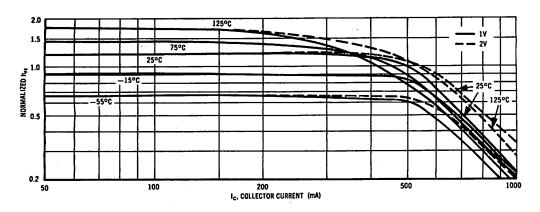
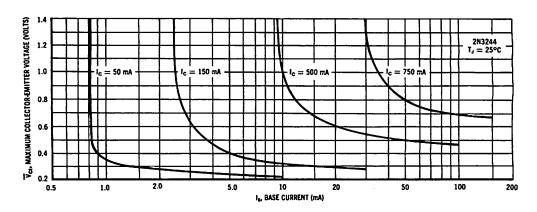


FIGURE 2 — COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS



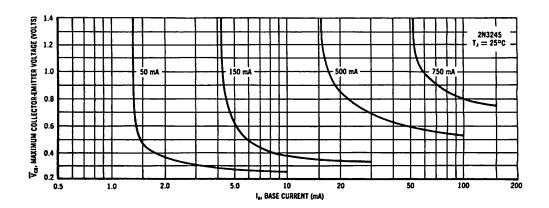


FIGURE 3 — MAXIMUM SATURATION VOLTAGES

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β_t = 10

Γ_s = 25°C

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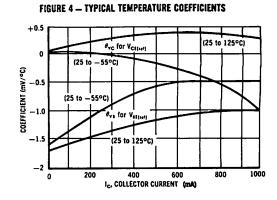
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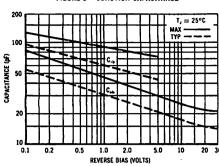
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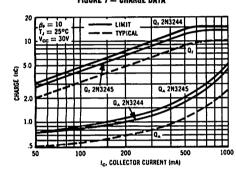


MOTOROLA SEMICONDUCTORS

FIGURE 5 - JUNCTION CAPACITANCE



·FIGURE 7 - CHARGE DATA



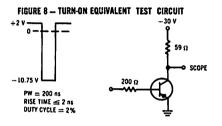


FIGURE 9 - TURN-OFF EQUIVALENT TEST CIRCUIT

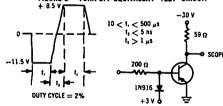


FIGURE 10 - Q, TEST CIRCUIT

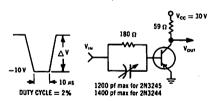
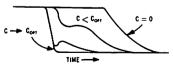


FIGURE 11 - TURN-OFF WAVEFORM



CASE 22, STYLE 1 TO-18 (TO-206AA)

SWITCHING TRANSISTOR

PNP SILICON

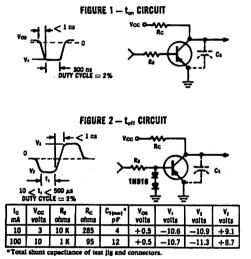
MAXIMUM RATINGS

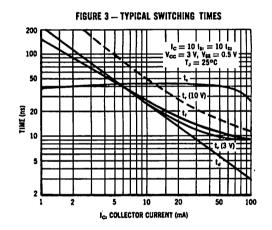
| Rating | Symbol | Value | Unit |
|---|-----------------------------------|--------------|----------------|
| Collector-Emitter Voltage | VCEO | 12 | Vdc |
| Collector-Base Voltage | VCBO | 15 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | ľc | 200 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.36 2.06 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 · 6.9 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

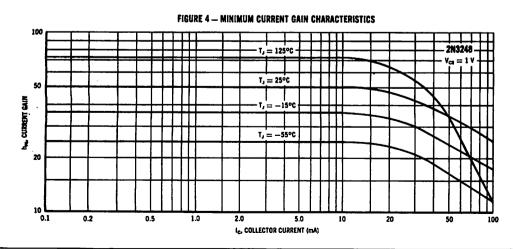
| Characteristic | Symbol | Min | Max | Unit |
|--|------------------|-------------------------------|-----------------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, Ig = 0) | V(BR)CEO | 12 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 15 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | V(BR)EBO | 5.0 | | Vdc |
| Base Cutoff Current (VCE = 10 Vdc, VBE = 1.0 Vdc) | IBEV | _ | 50 | nAdc |
| Collector Cutoff Current (VCE = 10 Vdc, VBE = 1.0 Vdc) (VCE = 10 Vdc, VBE = 1.0 Vdc, TA = 100°C) | ICEX | | 0.05 5.0 | μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain(1) (IC = 0.1 mAdc, VCE = 1.0 Vdc) (IC = 1.0 mAdc, VCE = 1.0 Vdc) (IC = 10 mAdc, VCE = 1.0 Vdc) (IC = 50 mAdc, VCE = 1.0 Vdc) (IC = 100 mAdc, VCE = 1.0 Vdc) | hFE | 100 100 100 75 35 | 300 | _ |
| Collector-Emitter Saturation Voltage(1) (IC = 10 mAdc, Ig = 1.0 mAdc) (IC = 50 mAdc, Ig = 5.0 mAdc) (IC = 100 mAdc, Ig = 10 mAdc) | VCE(sat) | 111 | 0.125 0.25 0.45 | Vdc |
| Base-Emitter Saturation Voltage(1) (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc) (I _C = 100 mAdc, I _B = 10 mAdc) | VBE(sat) | 0.6 0.7 — | 0.9 1.1 1.3 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | , |
| Current-Gain — Bandwidth Product (IC = 20 mAdc, VCE = 10 Vdc, f = 100 MHz) | fτ | 300 | | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | C _{obo} | _ | 8.0 | pF |
| Input Capacitance (VBE = 1.0 Vdc, IC = 0, f = 100 kHz) | C _{ibo} | | 8.0 | pF |

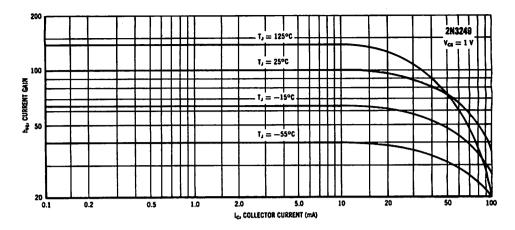
| | Characteristic | Symbol | Min | Max | Unit |
|---|---|------------------|-----|-----|------|
| SWITCHING CHARA | CTERISTICS | | | | |
| Delay Time | I _C = 100 mA, I _B = 10 mA, V _{BE} = 0.5 V, V _{CC} = 10 V | t _d | - | 5.0 | ns |
| Rise Time | | t _r | _ | 15 | ns |
| Storage Time | I _C = 100 mA, I _{B1} = I _{B2} = 10 mA, | ts | _ | 60 | ns |
| Fall Time | V _{CC} = 10 V | tf | _ | 20 | ns |
| Turn-On Time | I _C = 10 mA, I _{B1} = 1.0 mA, V _{BE} = 0.5 V, V _{CC} = 3.0 V | t _{on} | _ | 90 | ns |
| Turn-Off Time | I _C = 10 mA, I _{B1} = I _{B2} = 1.0 mA, V _{CC} = 3.0 V | ^t off | _ | 100 | ns |
| Total Control Charge (IC = 10 mA, IB = | 0.25 mA, V _{CC} = 3.0 V) | O _T | _ | 150 | рС |

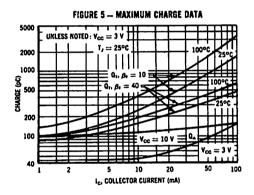
⁽¹⁾ Pulse Test: Pulse Width = 300 μ s, Duty Cycle \leq 2.0%.

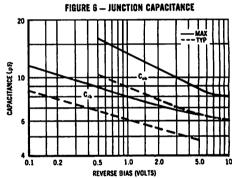


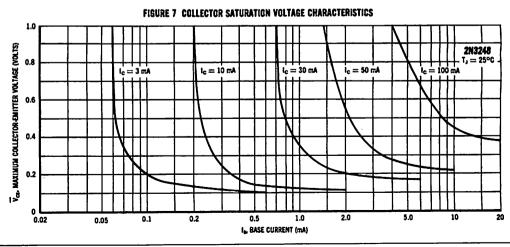


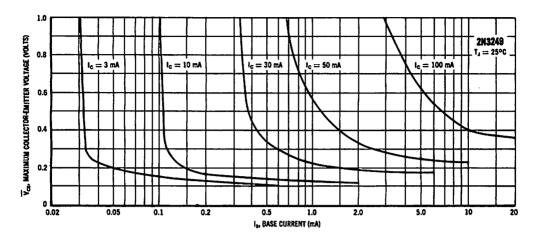


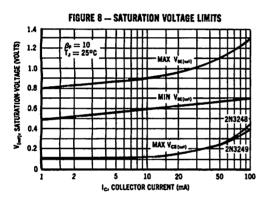












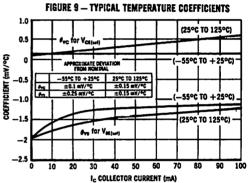


FIGURE 10 $-Q_T$ TEST CIRCUIT

VALUES REFER TO $I_C = 10$ mA TEST POINT

235

14.pF max

14.pF max

OUTY CYCLE = 2%

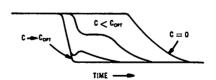


FIGURE 11 - TURN-OFF WAVE FORM

2N3250,A 2N3251,A

2N3250A,2N3251A JAN, JTX, JTXV AVAILABLE

> CASE 22, STYLE 1 TO-18 (TO-206AA)

GENERAL PURPOSE TRANSISTOR PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | | 2N3250A 2N3251A | Unit | | |
|---|----------------------|--------------|--------------------|----------------|--|-----|
| Collector-Emitter Voltage | VCEO | 40 | 60 | Vdc | | |
| Collector-Base Voltage | VCBO | 50 | 60 | Vdc | | |
| Emitter-Base Voltage | VEBO | 5.0 | | 5.0 | | Vdc |
| Collector Current | lc | 200 | | mAdc | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.36 2.06 | | Watt mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 6.9 | | Watts mW/°C | | |
| Operating and Storage Temperature Temperature Range | TJ, T _{stg} | -65 to +200 | | °C | | |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|-------|
| Thermal Resistance, Junction to Case | RøJC | 0.15 | mW/°C |
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 0.49 | mW/°C |

| Characteristic | | Symbol | Min | Max | Unit |
|--|------------------------------------|-----------------------|------------|-------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (1) (IC = 10 mAdc) | 2N3250, 2N3251 2N3250A, 2N3251A | V(BR)CEO | 40 60 | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc) | 2N3250, 2N3251 2N3250A, 2N3251A | V _(BR) CBO | 50 60 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 40 Vdc, VBE = 3.0 Vdc) | | ICEX | _ | 20 | Adc |
| Base Cutoff Current (VCE = 40 Vdc, VBE = 3.0 Vdc) | | IBL | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Forward Current Transfer Radio (1) (I _C = 0.1 mAdc, V _{CE} = 1.0 Vdc) | 2N3250, 2N3250A 2N3251, 2N3251A | hFE | 40 80 | _ | _ |
| (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) | 2N3250, 2N3250A 2N3251, 2N3251A | | 45 90 | = | |
| $(I_C = 10 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc})$ | 2N3250, 2N3250A 2N3251, 2N3251A | | 50 100 | 150 300 | |
| (I _C = 50 mAdc, V_{CE} = 1.0 Vdc) | 2N3250, 2N3250A 2N3251, 2N3251A | | 15 30 | _ | |
| Collector-Emitter Saturation Voltage (1) (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc) | | VCE(sat) | _ | 0.25 0.5 | Vdc |
| Base-Emitter Saturation Voltage (1) (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc) | | V _{BE(sat)} | 0.6 — | 0.9 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz) | 2N3250, 2N3250A 2N3251, 2N3251A | fT | 250 300 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | | C _{obo} | | 6.0 | pF |
| Input Capacitance (VCB = 1.0 Vdc, IC = 0, f = 100 kHz) | | C _{ibo} | - | 8.0 | pF |

2N3250,A, 2N3251,A

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

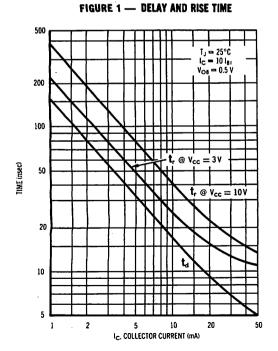
| Cheracteristic | | Symbol | Min | Max | Unit |
|---|------------------------------------|-----------------|------------|------------|--------|
| Input Impedance (I _C = 1.0 mA, V _{CE} = 10 V, f = 1.0 kHz) | 2N3250, 2N3250A 2N3251, 2N3251A | h _{ie} | 1.0 2.0 | 6.0 12 | kohms |
| Voltage Feedback Ratio (IC = 1.0 mA, VCE = 10 V, f = 1.0 kHz) | 2N3250, 2N3250A 2N3251, 2N3251A | h _{re} | | 10 20 | X 10-4 |
| Small-Signal Current Gain (IC = 1.0 mA, VCE = 10 V, f = 1.0 kHz) | 2N3250, 2N3250A 2N3251, 2N3251A | h _{fe} | 50 100 | 200 400 | |
| Output Admittance (tc = 1.0 mA, VcE = 10 V, f = 1.0 kHz) | 2N3250, 2N3250A 2N3251, 2N3251A | h _{oe} | 4.0 10 | 40 60 | μmhos |
| Collector Base Time Constant (IC = 10 mA, VCE = 20 V) | | rp,CC | _ | 250 | ps |
| Noise Figure (IC = 100 μ A, VCE = 5.0 V, RS = 1.0 k Ω , f = 100 Hz) | | NF | - | 6.0 | dB |

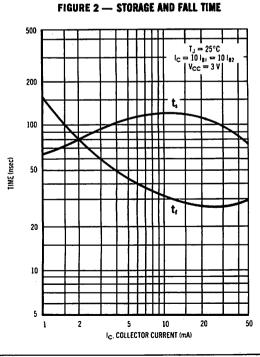
SWITCHING CHARACTERISTICS

| | Characteristic | | Symbol | Max | Unit |
|--------------|---|------------------------------------|----------------|------------|------|
| Delay Time | (VCC = 3.0 Vdc, VBE = 0.5 Vdc | | td | 35 | ns |
| Rise Time | I _C = 10 mAdc, I _{B1} = 1.0 mA) | | t _r | 35 | ns |
| Storage Time | (IC = 10 mAdc, IB1 = IB2 = 1.0 mAdc VCC = 3.0 V) | 2N3250, 2N3250A 2N3251, 2N3251A | t _S | 175 200 | ns |
| Fall Time | | | tf | 50 | ns |

(1) Pulse Test: PW = 300 μ s, Duty Cycle = 2.0%.

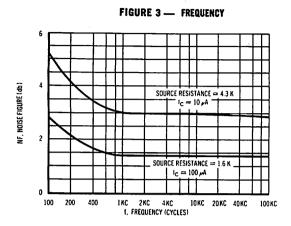
SWITCHING TIME CHARACTERISTICS

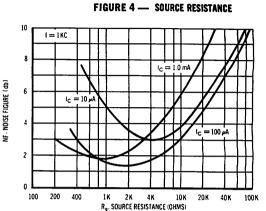




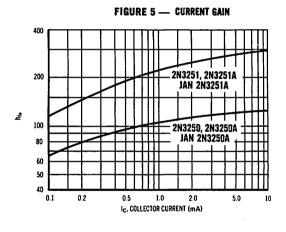
MOTOROLA SEMICONDUCTORS

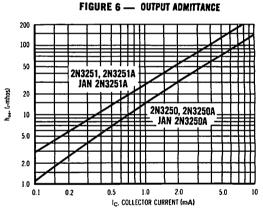
AUDIO SMALL SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS $(V_{ct}=6\,V,\,T_A=25^{\circ}\text{C})$

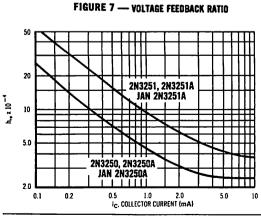




h PARAMETERS
V_{CE} = 10 V, f = 1 kc, T_A = 25°C







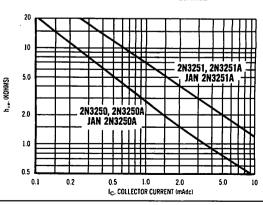


FIGURE 8 -- INPUT IMPEDANCE

FIGURE 9 - NORMALIZED CURRENT GAIN CHARACTERISTICS

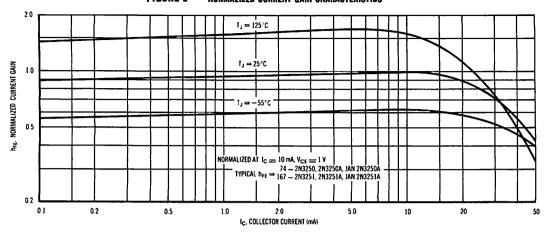
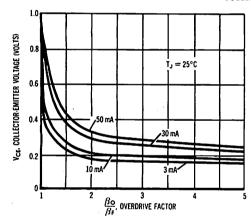


FIGURE 10 - COLLECTOR SATURATION REGION



This graph shows the effect of base current on collector current. β_O is the current gain of the transistor at 1 volt, and β_E (forced gain) is the ratio of I_C/I_{BE} in a circuit. EXAMPLE: For type 2N3251, estimate a base current (I_{BE}) to insure saturation at a temperature of 25°C and a collector current of 10 mA.

Observe that at $I_C \sim 10\,\text{mA}$ an overdrive factor of at least 2.5 is required to drive the transistor well into the saturation region. From Figure 1, it is seen that here (Q) 1 volt is typically 167 (guaranteed limits from the Table of Characteristics can be used for "worst-case" design). . .

$$\frac{\beta_{\rm O}}{\beta_{\rm F}} = \frac{h_{\rm FE} @ 1 \, \text{Volt}}{I_{\rm C}/I_{\rm BF}} \qquad 2.5 = \frac{167}{10 \, \text{mA/I}_{\rm BF}} \qquad I_{\rm BF} \approx 6.68 \, \text{mA typ}$$

FIGURE 11 — SATURATION VOLTAGES

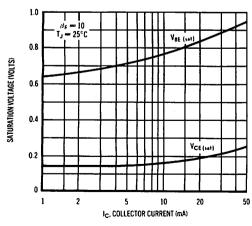
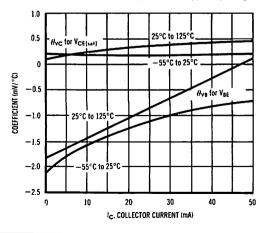


FIGURE 12 - TEMPERATURE COEFFICIENTS



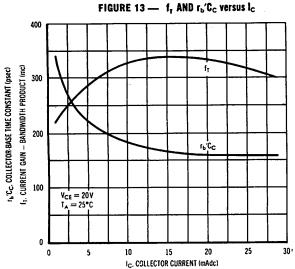


FIGURE 14 --- 30 MC EQUIVALENT CIRCUIT

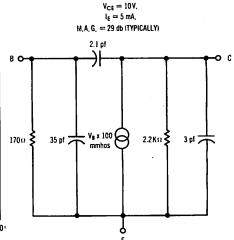


FIGURE 15 — JUNCTION CAPACITANCE

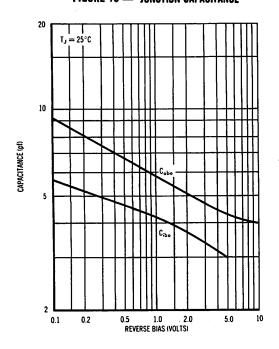
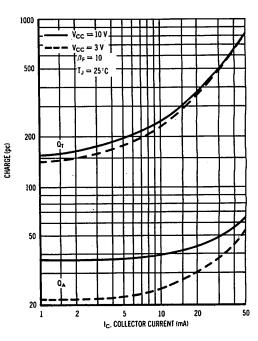


FIGURE 16 - CHARGE DATA



MAXIMUM RATINGS

| Rating | Symbol | 2N3252 | 2N3253 | 2N3444 | Unit | | | |
|--|-----------------------------------|-------------|--------|--------|----------------|--|--|-----|
| Collector-Emitter Voltage | VCEO | 30 | 40 | 50 | Vdc | | | |
| Collector-Base Voltage | VCBO | 60 | 75 | 80 | Vdc | | | |
| Emitter-Base Voltage | VEBO | 5.0 | | | 5.0 | | | Vdc |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 1.0 5.71 | | | Watts mW/°C | | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | | | Watts mW/°C | | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | | °C | | | |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|--------------------------------------|------------------|-------------|---------------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 35 0.175 | °C/W °C/mW |

2N3252 2N3253 2N3444

GENERAL PURPOSE

NPN SILICON

JAN, JTX AVAILABLE 2N3253, 2N3444 CASE 79, STYLE 1 TO-39 (TO-205AD)

| Characteristic | | Symbol | Min | Max | Unit |
|--|--|-----------------|----------------|------------------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, pulsed, Ig = 0) | 2N3252 2N3253 2N3444 | V(BR)CEO | 30 40 50 | _ _ _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | 2N3252 2N3253 2N3444 | V(BR)CBO | 60 75 80 | <u>-</u> | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | | V(BR)EBO | 5.0 | - | Vdc |
| Collector Cutoff Current (VCE = 40 Vdc, VEB(off) = 4.0 Vdc) (VCE = 60 Vdc, VEB(off) = 4.0 Vdc) | 2N3252 2N3253, 2N3444 | ICEX | = | 0.5 0.5 | μAdc |
| Collector Cutoff Current (VCB = 40 Vdc, E = 0) (VCB = 40 Vdc, E = 0, TA = 100°C) (VCB = 60 Vdc, E = 0) (VCB = 60 Vdc, E = 0, TA = 100°C) | 2N3252 2N3252 2N3253, 2N3444 2N3253, 2N3444 | ГСВО | _ | 0.50 75.0 0.50 75.0 | μAdc |
| Emitter Cutoff Current (VBE = 4.0 Vdc, IC = 0) | | (EBO | _ | 0.05 | μAdc |
| Base Cutoff Current (VCE = 40 Vdc, VEB(off) = 4.0 Vdc) (VCE = 60 Vdc, VEB(off) = 4.0 Vdc) | 2N3252 2N3253, 2N3444 | ¹ BL | 1 1 | 0.50 0.50 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(1) (IC = 150 mAdc, V _{CE} ≈ 1.0 Vdc) | 2N3252 2N3253 2N3444 | hFE | 30 25 20 | = | _ |
| (I _C = 500 mAdc, V _{CE} = 1.0 Vdc) | 2N3252 2N3253 2N3444 | | 30 25 20 | 90 75 60 | |
| (IC = 1.0 Adc, V _{CE} = 5.0 Vdc) | 2N3252 2N3253 2N3444 | | 25 20 15 | = | |

2N3252, 2N3253, 2N3444

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

| | Symbol | Min | Max | Unit |
|----------------|--|--|--------|--------|
| | V _{CE(sat)} | | 1 | Vdc |
| 2N3252 | 1 02,020 | _ | 0.3 | |
| 2N3253, 2N3444 | 1 | _ | 0.35 | 1 |
| 2N3252 | | _ | 0.5 | ł |
| 2N3253, 2N3444 | | - | 0.60 | ļ |
| 2N3252 | | _ | 1.0 | |
| 2N3253, 2N3444 | | | 1.2 | |
| | V _{BE(sat)} | | | Vdc |
| | | _ | 1.0 | |
| | | 0.7 | 1.3 | Į |
| | | - | 1.8 | |
| | 2N3253, 2N3444 2N3252 2N3253, 2N3444 2N3252 | 2N3252 2N3253, 2N3444 2N3252 2N3253, 2N3444 2N3252 2N3253, 2N3444 | 2N3252 | 2N3252 |

SMALL-SIGNAL CHARACTERISTICS

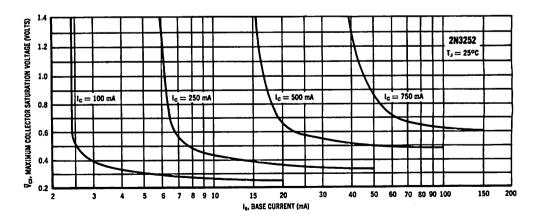
| Current-Gain — Bandwidth Product | | fT | | | MHz |
|---|----------------|------------------|-----|----|-----|
| (I _C = 50 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | 2N3252 | 1 | 200 | - | 1 . |
| · · · · · · · · · · · · · · · · · · · | 2N3253, 2N3444 | | 175 | l | |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | | C _{obo} | _ | 12 | pF |
| Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 100 kHz) | | C _{ibo} | _ | 80 | pF |

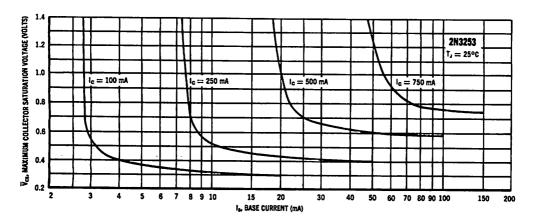
SWITCHING CHARACTERISTICS

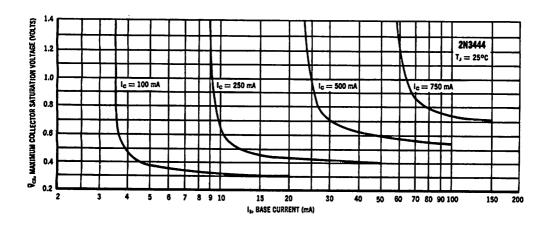
| Delay Time | IC = 500 mAdc, IB1 = 50 mAdc | | t _d | _ | 15 | ns |
|--|--|----------------|----------------|-----|----|----|
| Rise Time | VCC = 30 V, VBE = 2.0 V 2N3252 | t _r | - | 30 | ns | |
| | 21932 | 2N3253, 2N3444 | | _ | 35 | |
| Storage Time | IC = 500 mAdc, IB1 = IB2 = 50 mAdc VCC = 30 V | | ts | 1 | 40 | ns |
| Fall Time | | | tf | 1 | 30 | ns |
| Total Control Charge (IC = 500 mAdc, IB1 = 50 mAdc, VCC = 30 V) | | QΤ | 1 | 5.0 | nC | |

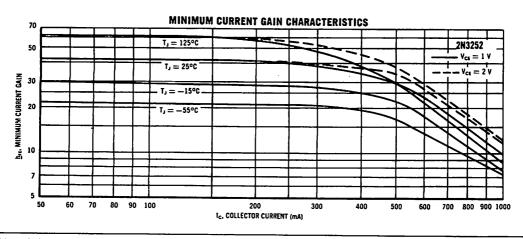
⁽¹⁾ Pulse Test: Pulse Width = 300 µs, Duty Cycle = 2.0%.

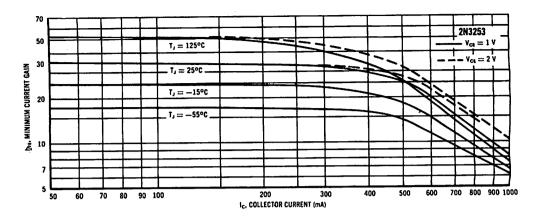
COLLECTOR SATURATION VOLTAGE CHARACTERISTICS

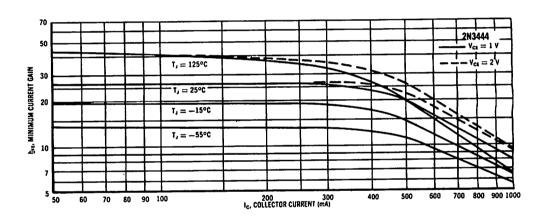


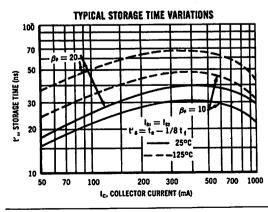


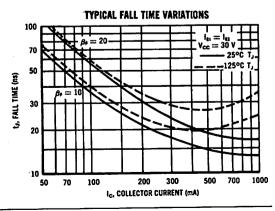




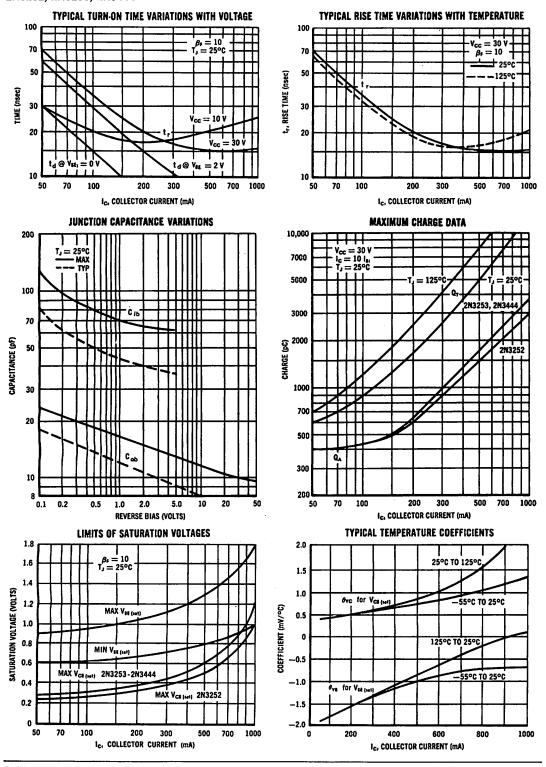








2N3252, 2N3253, 2N3444



2N3299 2N3300

CASE 79, STYLE 1 TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTOR

2N3301 2N3302

CASE 22, STYLE 1 TO-18 (TO-206AA)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| THANIMON NATURGS | | | | | | |
|---|----------------------|------------------|------------------|----------------|--|------|
| Rating | Symbol | Va | lue | Unit | | |
| Collector-Emitter Voltage (Applicable 0 to 10 mAdc) | VCEO | VCEO 30 | | Vdc | | |
| Collector-Base Voltage | VCBO | 6 | 30 | Vdc | | |
| Emitter-Base Voltage | VEBO | 5 | .0 | Vdc | | |
| Collector Current — Continuous | Ic | 500 | | 500 | | mAdc |
| | | 2N3299 2N3300 | 2N3301 2N3302 | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.8 4.56 | 0.36 2.06 | Watt mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 3.0 17.2 | 1.8 10.3 | Watts mW/°C | | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | - 65 to | +200 | °C | | |

Refer to 2N2218 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|--|--|-------------|---------|
| OFF CHARACTERISTICS | | - | | |
| Collector-Emitter Sustaining Voltage(1) (I _C = 10 mAdc, I _B = 0) | V _{CEO(sus)} | 30 | | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | V(BR)CBO | 60 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 50 Vdc, VBE = 0) (VCE = 50 Vdc, VBE = 0, TA = 150°C) | lCES | | 0.01 10 | μAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | l _{EBO} | _ | 10 | nAdc |
| Base Current (VCE = 50 Vdc, VBE = 0) | 1B | | 10 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 0.1 mAdc, VCE = 10 Vdc) (IC = 1.0 mAdc, VCE = 10 Vdc) (IC = 1.0 mAdc, VCE = 10 Vdc) (IC = 10 mAdc, VCE = 10 Vdc) (IC = 10 mAdc, VCE = 10 Vdc)(1) (IC = 150 mAdc, VCE = 10 Vdc)(1) (IC = 150 mAdc, VCE = 10 Vdc)(1) (IC = 150 mAdc, VCE = 10 Vdc)(1) (IC = 500 mAdc, VCE = 10 Vdc)(1) (IC = 500 mAdc, VCE = 10 Vdc)(1) (IC = 500 mAdc, VCE = 10 Vdc)(1) (IC = 500 mAdc, VCE = 10 Vdc)(1) (IC = 500 mAdc, VCE = 10 Vdc)(1) (IC = 500 mAdc, IB = 15 mAdc) (IC = 500 mAdc, IB = 50 mAdc) (IC = 500 mAdc, IB = 50 mAdc) (IC = 500 mAdc, IB = 50 mAdc) | 1002 1001 1002 1002 1001 1002 1001 1002 | 20 35 25 50 35 75 20 50 40 100 20 50 ——————————————————————————————— | | Vdc Vdc |
| Base Emitter Voltage (I _C = 150 mA, V _{CE} = 10 V) | V _{BE(on)} | | 1.1 V | Max |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 10 Vdc, f = 100 | MHz) f _T | 250 | | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 140 kHz) | C _{obo} | _ | 8.0 | pF |
| Input Capacitance (VBE = 2.0 Vdc, IC = 0, f = 140 kHz) | C _{ibo} | _ | 20 | ρF |
| SWITCHING CHARACTERISTICS | - | | | |
| Turn-On Time (V _{CC} = 25 Vdc, I _C = 300 mAdc, I _{B1} = 30 mAdc) | t _{on} | 1 | 60 | ns |
| Turn-Off Time (V _{CC} = 25 Vdc, I _C = 300 mAdc, I _{B1} = I _{B2} = 30 mAdc) | toff | _ | 150 | ns |

MAXIMUM RATINGS

| MACAMONI INTINGO | | | | |
|---|-----------------------------------|-------------|----------|-------------|
| Rating | Symbol | 2N3307 | 2N3308 | Unit |
| Collector-Emitter Voltage | VCEO | 35 | 25 | Vdc |
| Collector-Emitter Voltage | VCES | 40 | 30 | Vdc |
| Collector-Base Voltage | VCBO | 40 | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 3 | .0 | Vdc |
| Collector Current — Continuous | lc | 5 | io | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 200 1.14 | | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | _ | 00 71 | mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 65 to | + 200 | °C |

2N3307 2N3308

CASE 20, STYLE 10 TO-72 (TO-206AF)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

| Characteristic | | Symbol | Min | Max | Unit |
|---|------------------|-----------------------|------------|--------------|------|
| OFF CHARACTERISTICS | | | | | · |
| Collector-Emitter Breakdown Voltage (I _C = 2.0 mAdc, I _B = 0) | 2N3307 2N3308 | V _(BR) CEO | 35 25 | = | Vdc |
| Collector-Emitter Breakdown Voltage (I _C = 10 µAdc, V _{BE} = 0) | 2N3307 2N3308 | V(BR)CES | 40 30 | = | Vdc |
| Collector-Base Breakdown Voltage(1) (I _C = 10 µAdc, I _E = 0) | 2N3307 2N3308 | V(BR)CBO | 40 30 | = | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 μ Adc, IC = 0) | | V(BR)EBO | 3.0 | - | Vdc |
| Collector Cutoff Current (V _{CB} = 15 Vdc) (V _{CB} = 15 Vdc, T = 150°C) | 2N3307 | Ісво | _ | 0.010 3.0 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (VCE = 10 Vdc, I _C = 2.0 mAdc) | 2N3307 2N3308 | hFE | 40 25 | 250 250 | _ |
| Collector-Emitter Saturation Voltage (IC = 3.0 mAdc, Ig = 0.6 mAdc) | | V _{CE(sat)} | _ | 0.4 | Vdc |
| Base-Emitter Saturation Voltage (IC = 3.0 mAdc, IB = 0.6 mAdc | | V _{BE(sat)} | | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | L |
| Current-Gain — Bandwidth Product (V _{CE} = 10 Vdc, I _C = 2.0 mAdc, f = 100 MHz | | fT | 300 | 1200 | MHz |
| Maximum Frequency of Operation (VCE = 10 Vdc, IC = 2.0 mAdc) | | f _{max} | | pical 300 | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 0.1 MHz | 2N3307 2N3308 | C _{obo} | | 1.3 1.6 | pF |
| Small-Signal Current Gain (VCE = 10 Vdc, I _C = 2.0 mAdc, f = 1 kHz) | 2N3307 2N3308 | h _{fe} | 40 25 | 250 250 | _ |
| Collector Base Time Constant (VCB = 10 Vdc, I _C = 2.0 mAdc, f = 31.8 MHz) | 2N3307 2N3308 | rb'C _C | 2.0 2.0 | 15 20 | ps |

2N3307, 2N3308

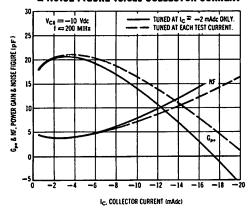
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------|--------|-----|-----|------|
| Noise Figure | | NF | | | dB |
| (VCE = 10 Vdc, IC = 2.0 mAdc, f = 200 MHz) | 2N3307 | | _ | 4.5 | |
| 1106 1111110 | 2N3308 | | - | 6.0 | |

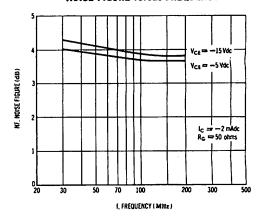
SWITCHING CHARACTERISTICS

| Power Gain(2) | | Ge | 17 | _ | d₿ |
|--|--------|----|----------------|---|----|
| (VCE = 10 Vdc, IC = 2.0 mAdc, f = 200 MHz) | | | | | |
| Power Gain (AGC)(2) | | Ge | Ì | ļ | ₫B |
| (VCE = 5.0 Vdc, IC = 20 mAdc, f = 200 MHz) | 2N3307 | | _ | 0 | |
| 1 . 02 | 2N3308 | 1 | l - | - | |

COMMON EMITTER AVERAGE SMALL POWER GAIN & NOISE FIGURE versus COLLECTOR CURRENT



NOISE FIGURE Versus FREQUENCY



⁽¹⁾ C_{obo} is measured in guarded circuit such that the can capacitance is not included.
(2) AGC is obtained by increasing I_C. The circuit remains adjusted for V_{CE} = -10 Vdc, I_C = -2 mAdc operation.

| MAXIMUM RATINGS | | | | | | | |
|--|-----------------------------------|-------------|--------|-------------|--------|----------------|----------------|
| | | Pi | VP 9 | N | PN | | |
| Rating | Symbol | 2N5415 | 2N5416 | 2N3439 | 2N3440 | Unit | |
| Collector-Emitter Voltage | VCEO | 200 | 300 | 350 | 250 | Vdc | |
| Collector-Base Voltage | VCBO | 200 | 350 | 450 | 300 | Vdc | |
| Emitter-Base Voltage | VEBO | 4.0 | 6.0 | 7.0 | 7.0 | Vdc | |
| Base Current | I _B | | 0.5 | | | | |
| Collector Current — Continuous | lc | 1.0 | | | Adc | | |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | | | 1.0 5.7 | | Watts mW/°C | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 10 57 | | 5.0 28.6 | | Watts mW/°C | |
| Total Device Dissipation @ TA = 50°C Derate above 50°C | PD | 1.0 6.7 | | 1 112 | | _ | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | | °C | | |

2N3439, 2N3440 NPN 2N5415, 2N5416 PNP

JAN, JTX, JTXV AVAILABLE CASE 79-02, STYLE 1 TO-39 (TO-205AD)

THERMAL CHARACTERISTICS

| Characteristic | Symbol | 2N5415 2N5416 | 2N3439 2N3440 | Unit |
|---|--------|------------------|------------------|------|
| Thermal Resistance, Junction to Case | ReJC | 17.5 | 35 | °C/W |
| Thermal Resistance, Junction to Ambient | ReJA | 150 | 175 | °C/W |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteri | istic | Symbol | Min | Max | Unit |
|---|--|----------------------|------------|----------------|------|
| OFF CHARACTERISTICS | | - | | | |
| Collector-Emitter Sustaining Voltage(1) (I _C = 50 mAdc, I _B = 0) | 2N5415 2N5416 | VCEO(sus) | 200 300 | _ | Vdc |
| | 2N3439 2N3440 | | 350 250 | = | |
| *Collector Cutoff Current (VCE = 300 Vdc, I _B = 0) (VCE = 200 Vdc, I _B = 0) | 2N3439 2N3440 | ICEO | = | 20 50 | μAdc |
| *Collector Cutoff Current (VCE = 450 Vdc, VBE = 1.5 Vdc) (VCE = 300 Vdc, VBE = 1.5 Vdc) | 2N3439 2N3440 | ICEX | _ | 500 500 | μAdc |
| Collector Cutoff Current (V _{CB} = 175 Vdc, I _E = 0) (V _{CB} = 280 Vdc, I _E = 0) (V _{CB} = 360 Vdc, I _E = 0) | 2N5415 2N5416 2N3439 | ІСВО | = | 50 50 20 | μAdc |
| (V _{CB} = 250 Vdc, I _E = 0) Emitter Cutoff Current (V _{EB} = 4.0 Vdc, I _C = 0) (V _{EB} = 6.0 Vdc, I _C = 0) | 2N3440 2N5415 2N5416, 2N3439, 2N3440 | l _{EBO} | | 20 20 20 | μAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain (I _C = 2.0 mAdc, V _{CE} = 10 Vdc) *(I _C = 20 mAdc, V _{CE} = 10 Vdc) | 2N3439 2N3439, 2N3440 | ptE | 30 40 | _ 160 | _ |
| *(IC = 50 mAdc, VCE = 10 Vdc) | 2N5415 2N5416 | | 30 30 | 150 120 | |
| Collector-Emitter Saturation Voltage (I _C = 50 mAdc, I _B = 4.0 mAdc) | 2N3439, 2N3440 | V _{CE(sat)} | _ | 0.5 | Vđc |
| Base-Emitter Saturation Voltage (IC = 50 mAdc, IB = 4.0 mAdc) | 2N3439, 2N3440 | V _{BE(sat)} | - | 1.3 | Vdc |

2N3439, 2N3440 NPN / 2N5415, 2N5416 PNP

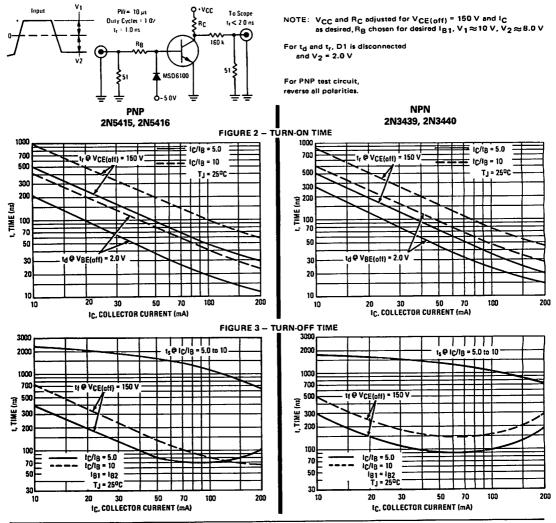
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|--|-----------------------------------|----------------------|-----|----------|------|
| SMALL-SIGNAL CHARACTERISTICS | | • | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 10 Vdc, f = 50 MHz) | 2N3439, 2N3440 | ſΤ | 15 | _ | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz) | 2N5415, 2N5416, 2N3439, 2N3440 | C _{obo} | 1 1 | 15 10 | pF |
| Input Capacitance (VEB = 5.0 Vdc, I _C = 0, f = 1.0 MHz) | | C _{ibo} | 1 | 75 | pF |
| Small-Signal Current Gain (I _C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) (I _C = 10.0 mAdc, V_{CE} = 10 Vdc, f = 5.0 MHz) | 2N5415, 2N5418 | h _{fe} | 25 | _ | _ |
| Real Part of Input Impedance (VCE = 10 Vdc, IC = 5.0 mAdc, f = 1.0 MHz) | | Re(h _{ie}) | _ | 300 | Ohms |

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

CAUTION: The sustaining voltage must not be measured on a curve tracer. (See Fig. 15.)

FIGURE 1 - SWITCHING TIMES TEST CIRCUIT



2N3439, 2N3440 NPN / 2N5415, 2N5416 PNP

FIGURE 4 - CURRENT-GAIN - BANDWIDTH PRODUCT

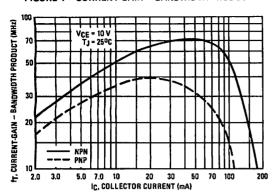


FIGURE 5 - CAPACITANCE

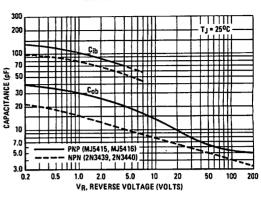


FIGURE 6 - THERMAL RESPONSE

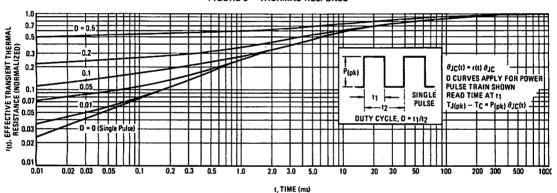
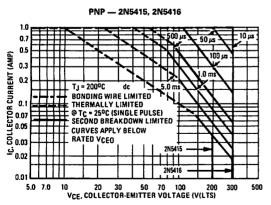
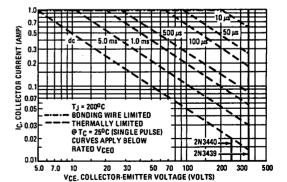


FIGURE 7 - ACTIVE-REGION SAFE OPERATING AREA





NPN - 2N3439, 2N3440

200

100 70

50

30

20

10

7.0

5.0

3.0

2.0 0.5

hFE, DC CURRENT GAIN

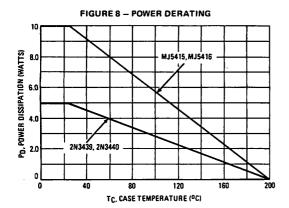
TJ = 150°C

- 25°C

VCE = 2.0 Volts

VCE = 10 Volts

2N3439, 2N3440 NPN / 2N5415, 2N5416 PNP



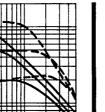
There are two limitations on the power handling ability of a transistor, average junction temperature and second breakdown. Safe operating area curves indicate IC-VCE limits of the transistor that must be observed for reliable operation; i.e., the transistor must not be subjected to greater dissipation than the curves indicate.

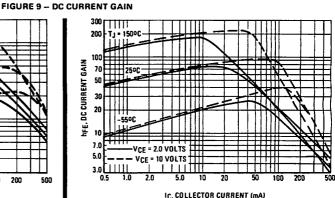
The data of Figure 7 is based on T_{J(pk)} = 200°C; T_C is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided $T_J(p_k) < 200^\circ C$. $T_J(p_k)$ may be calculated from the data in Figure 6. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown. (See AN-415).

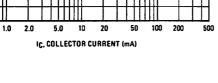
NPN

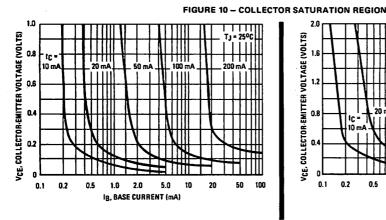


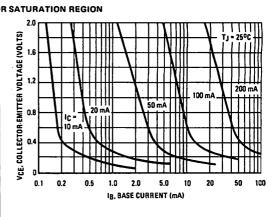
2N3439 2N3440





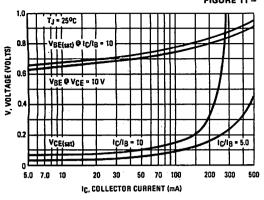






2N3439, 2N3440 NPN / 2N5415, 2N5416 PNP

FIGURE 11 - "ON" VOLTAGES



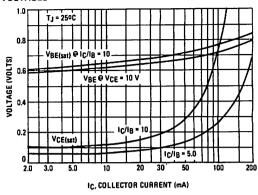
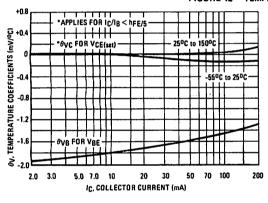
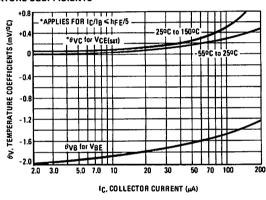
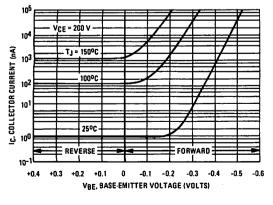


FIGURE 12 - TEMPERATURE COEFFICIENTS









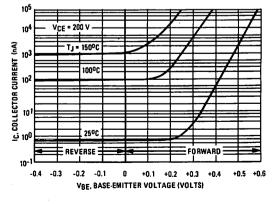


FIGURE 14 – BA

103

TJ = 150°C

VCE = 200 V

103

104

105

107

REVERSE

FORWARD

108

VBE, BASE-EMITTER VOLTAGE (VOLTS)

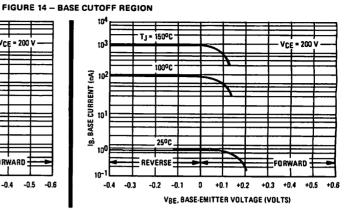
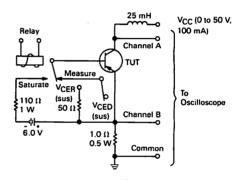


FIGURE 15 — CIRCUIT USED TO MEASURE SUSTAINING VOLTAGES



| Marking III III III III | | | | |
|---|-----------------------------------|-------------|--------|----------------|
| Rating | Symbol | 2N3467 | 2N3468 | Unit |
| Collector-Emitter Voltage | VCEO | 40 | - 50 | Vdc |
| Collector-Base Voltage | V _{CBO} | 40 | . 50 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc |
| Collector Current — Continuous | lc | 1.0 | | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.71 | | Watt mW/℃ |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|-------|-------|
| Thermal Resistance, Junction to Case | ReJC | 35 | •c/w |
| Thermal Resistance, Junction to Ambient | Baix | 0.175 | °C/mW |

2N3467 2N3468

JAN, JTX, JTXV AVAILABLE CASE 079-02, STYLE 1 TO-39 (TO-205AD)

SWITCHING TRANSISTOR

PNP SILICON

| Characteristic | | Symbol | Min | Max | Unit |
|--|------------------|----------------------|----------|-------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, Ig = 0) | 2N3467 2N3468 | V(BR)CEO | 40 50 | = | Vdc |
| Collector-Base Breakdown Voltage | 2N3467 2N3468 | V(BR)CBO | 40 50 | = | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | | V(BR)EBO | 5.0 | - | Vdc |
| Base Cutoff Current (VCE = -30 Vdc, VBE = 3.0 Vdc) | | IBEV | _ | 120 | nAdc |
| Collector Cutoff Current (VCE = -30 Vdc, VBE = 3.0 Vdc) | | ICEX | _ | 100 | Adc |
| Collector Cutoff Current (V _{CB} = 30 Vdc, I _E = 0) (V _{CB} = 30 Vdc, I _E = 0, T _A = 100°C) | | ICBO | = | 0.10 15 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(1) (I _C = 150 mAdc, V _{CE} = 1.0 Vdc) | 2N3467 2N3468 | hFE | 40 25 | - | _ |
| (IC = 500 mAdc, V_{CE} = 1.0 Vdc) | 2N3467 2N3468 | | 40 25 | 120 75 | |
| (I _C = 1.0 Adc, V _{CE} = 5.0 Vdc) | 2N3467 2N3468 | | 40 20 | _ | |
| Collector-Emitter Saturation Voltage(1) (IC = 150 mAdc, IB = 15 mAdc) | 2N3467 2N3468 | VCE(sat) | = | 0.3 0.36 | Vdc |
| (I _C = 500 mAdc, I _B = 50 mAdc) | 2N3467 2N3468 | | _ | 0.5 0.6 | |
| (I _C = 1.0 Adc, I _B = 100 mAdc) | 2N3467 2N3468 | | _ | 1.0 1.2 | |
| Base-Emitter Saturation Voltage(1) (IC = 150 mAdc, IB = 15 mAdc) (IC = 500 mAdc, IB = 50 mAdc) (IC = 1.0 Adc, IB = 100 mAdc) | | V _{BE(sat)} | 0.8 | 1.0 1.2 1.6 | Vdc |

2N3467, 2N3468

Fall Time

Total Control Charge

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

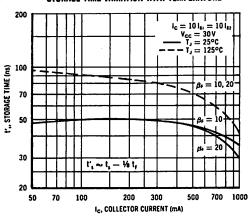
| | Characteristic | | Symbol | Min | Max | Unit |
|---|--|------------------|------------------|------------|-----|------|
| SMALL-SIGNAL CH | IARACTERISTICS | | | | | - |
| Current-Gain — Bar (IC = 50 mAdc, V | CE = 10 Vdc, f = 100 MHz) | 2N3467 2N3468 | fτ | 175 150 | = | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, I _E | = 0, f = 100 kHz) | | C _{obo} | _ | 25 | pF |
| Input Capacitance (VEB = 0.5 Vdc, I | C = 0, f = 100 kHz) | | C _{ibo} | _ | 100 | pF |
| SWITCHING CHARA | ACTERISTICS | | | | , | |
| Delay Time | (IC = 500 mA, IB1 = 50 mA, VBE = | | t _d | _ | 10 | ns |
| Rise Time | 2.0 V, V _{CC} = 30 V) | | t _r | _ | 30 | ns |
| Storage Time | (IC = 500 mA, IB1 = IB2 = 50 mA, VCC = | = 30 V) | ts | _ | 60 | กร |

⁽IC = 500 mA, IB = 50 mA, VCC = 30 V) (1) Pulse Test: PW \leq 300 μ s, Duty Cycle \leq 2.0%.

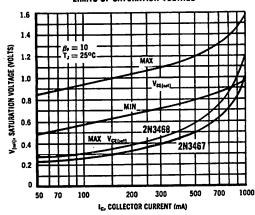
STORAGE TIME VARIATION WITH TEMPERATURE

tf

Qτ



LIMITS OF SATURATION VOLTAGE

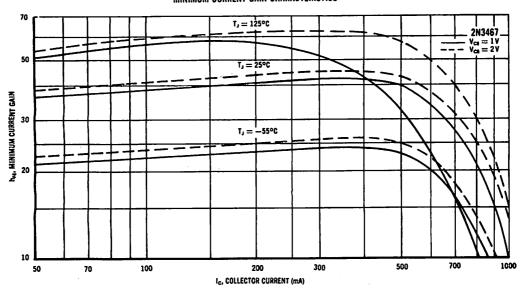


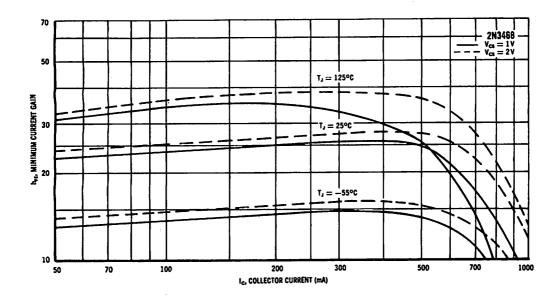
กร

nC

6.0

MINIMUM CURRENT GAIN CHARACTERISTICS





2N3494 2N3495

CASE 31-03, STYLE 1 TO-39 (TO-205AD)

2N3496 2N3497

CASE 22-03, STYLE 1 TO-18 (TO-206AA)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | 2N3494 2N3496 | 2N3495 2N3497 | Unit |
|---|-----------------------------------|------------------|------------------|----------------|
| Collector-Emitter Voltage | VCEO | 80 | 120 | Vdc |
| Collector-Base Voltage | VCBO | 80 | 120 | Vdc |
| Emitter-Base Voltage | VEBO | 4.5 | | Vdc |
| Collector Current — Continuous | lc | 100 | | mAdc |
| | | 2N3494 2N3495 | 2N3496 2N3497 | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 600 3.43 | 400 2.28 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C° Derate above 25°C | PD | 3.0 17.2 | 1.2 6.85 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | °C |

^{*}Indicates Data in addition to JEDEC Requirements.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|--|---------------------------------------|----------------------|----------------------------|-------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | 2N3494, 2N3496 2N3495, 2N3497 | V(BR)CEO | 80 120 | _ | Vdc |
| (IC = 10 μ Adc, IE = 0) | 2N3494, 2N3496 2N3495, 2N3497 | V(BR)CBO | 80 120 | = | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | | V(BR)EBO | 4.5 | - | Vdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) (VCB = 90 Vdc, IE = 0) | 2N3494, 2N3496 2N3495, 2N3497 | ICBO | = | 100 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | | l _{EBO} | _ | 25 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(1) (I _C = 100 µAdc, V _{CE} = 10 Vdc) (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc) (I _C = 50 mAdc, V _{CE} = 10 Vdc) (I _C = 100 mAdc, V _{CE} = 10 Vdc) | 2N3494, 2N3496 | hFE | 35 40 40 40 35 | | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | 2N3494, 2N3496 2N3495, 2N3497 | VCE(sat) | = | 0.3 0.35 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | · · · · · · · · · · · · · · · · · · · | V _{BE(sat)} | 0.6 | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | · |
| Current-Gain — Bandwidth Product(2) (I _C = 20 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | 2N3494, 2N3496 2N3495, 2N3497 | ÍΤ | 200 150 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | 2N3494, 2N3496 2N3495, 2N3497 | C _{obo} | = | 7.0 6.0 | pF |
| Input Capacitance (VBE = 2.0 Vdc, IC = 0, f = 100 kHz) | | C _{ibo} | _ | 30 | pF |

2N3494, 2N3495, 2N3496, 2N3497

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|---|----------------------|--------|-----|--------|
| Input Impedance (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{ie} | 0.1 | 1.2 | k ohms |
| Voltage Feedback Ratio (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{re} | \$.T.L | 2.0 | X 10-4 |
| Small-Signal Current Gain (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | hfe | 40 | 300 | - IL- |
| Output Admittance (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{oe} | 117 | 300 | μmhos |
| Real Part of Input Impedance (I _C = 20 mAdc, V _{CE} = 10 Vdc, f = 300 MHz) | Re(h _{ie}) | _ | 30 | Ohms |

SWITCHING CHARACTERISTICS

| Turn-On Time ($V_{CC} = 30 \text{ Vdc}$, $I_{C} = 10 \text{ mAdc}$, $I_{B1} = 1.0 \text{ mAdc}$) | ton | L L L | 300 | ns |
|--|------|-------|------|----|
| Turn-Off Time $(V_{CC} = 30 \text{ Vdc}, I_C = 10 \text{ mAdc}, I_{B1} = I_{B2} = 1.0 \text{ mAdc})$ | toff | - | 1000 | ns |

- (1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2.0%.
- (2) fr is defined as the frequency at which |hfe| extrapolates to unity.

FIGURE 1 - TURN-ON TIME TEST CIRCUIT

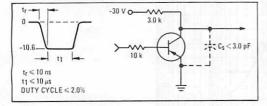


FIGURE 3 - VCE (sat) versus IC

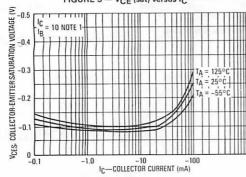


FIGURE 5 - hFE versus IC

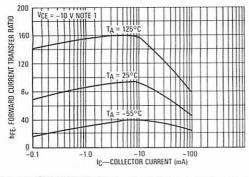


FIGURE 2 - TURN-OFF TIME TEST CIRCUIT

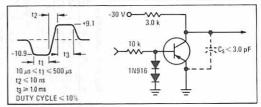


FIGURE 4 - ICBO versus TA

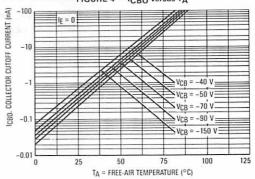
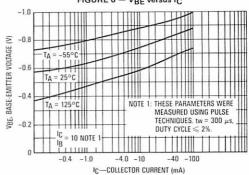
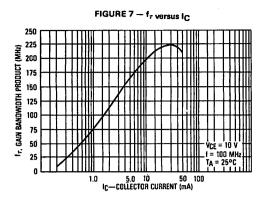


FIGURE 6 - VBE versus IC



MOTOROLA SEMICONDUCTORS



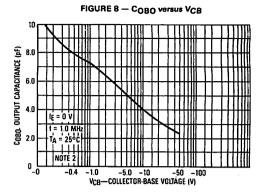
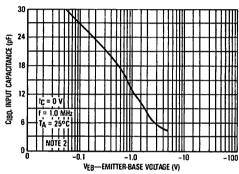


FIGURE 9 — CIBO versus VEB



NOTE 2: CAPACITANCE MEASURE MADE WITH TO-18 PACKAGE.

| IADVIIAIOIAI INTIIIAOO | | | | |
|---|-----------------------------------|------------------|------------------|----------------|
| Rating | Symbol | 2N3498 2N3499 | 2N3500 2N3501 | Unit |
| Collector-Emitter Voltage | VCEO | 100 | 150 | Vdc |
| Collector-Base Voltage | VCBO | 100 | 150 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | | Vdc |
| Collector Current — Continuous | lc | 500 | 300 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.71 | | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | °C |

THERMAL CHARACTERISTICS

| | Characteristic | Symbol | Max | Unit |
|---|---|-------------------|-----|------|
| ı | Thermal Resistance, Junction to Case | R _Ø JC | 35 | °C/W |
| | Thermal Resistance, Junction to Ambient | Reja | 175 | °C/W |

2N3498 thru 2N3501

JAN, JTX, JTXV AVAILABLE CASE 79-02, STYLE 1 TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|--|------------------|---|----------|----------------------------|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage (1) (IC = 10 mAdc, IB = 0) | 2N3498, 2N3499 2N3500, 2N3501 | V(BR)CEO | 100 150 | | | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | 2N3498, 2N3499 2N3500, 2N3501 | V(BR)CBO | 100 150 | | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | | V(BR)EBO | 6.0 | | _ | Vdc |
| Collector Cutoff Current (VCB = 50 Vdc, E = 0) (VCB = 50 Vdc, E = 0, TA = 150°C) (VCB = 75 Vdc, E = 0) (VCB = 75 Vdc, E = 0, TA = 150°C) | 2N3498, 2N3499 2N3500, 2N3501 | СВО | | | 0.050 50 0.050 50 | μAdc |
| Emitter Cutoff Current (VBE(off) = 4.0 Vdc, 1 _C = 0) | | [‡] EBO | _ | <u> </u> | 25 | nAdc |
| ON CHARACTERISTICS | | | | | | - |
| DC Current Gain (IC = 0.1 mAdc, VCE = 10 Vdc) | 2N3498, 2N3500 2N3499, 2N3501 | hFE | 20 35 | = | = | _ |
| (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) | 2N3498, 2N3500 2N3499, 2N3501 | | 25 50 | = | = | |
| (I _C = 10 mAdc, V _{CE} = 10 Vdc) | 2N3498, 2N3500 2N3499, 2N3501 | | 35 75 | _ | = | |
| (IC = 150 mAdc, VCE = 10 Vdc) | 2N3498, 2N3500 2N3499, 2N3501 | | 40 100 | = | 120 300 | |
| (I _C = 300 mAdc, V _{CE} = 10 Vdc) | 2N3500 2N3501 | | 15 20 | = | = | |
| (I _C = 500 mAdc, V _{CE} = 10 Vdc) | 2N3498 2N3499 | | 15 20 | = | = | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) (IC = 50 mAdc, Ig = 5.0 mAdc) (IC = 150 mAdc, Ig = 15 mAdc) (IC = 300 mAdc, Ig = 30 mAdc) | All Types All Types 2N3500, 2N3501 2N3498, 2N3499 | VCE(sat) | ======================================= | _ | 0.2 0.25 0.4 0.6 | Vdc |

2N3498 thru 2N3501

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

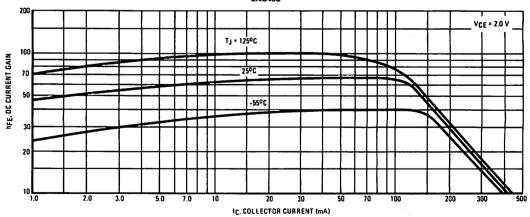
Characteristic

| Ollaracteristic | | Symbol | MILLI | тур | iviax . | Unit |
|---|--|------------------|-------------|-----|--------------------------|--------|
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc) (IC = 150 mAdc, IB = 15 mAdc) (IC = 300 mAdc, IB = 30 mAdc) | All Types All Types 2N3500, 2N3501 2N3498, 2N3499 | VBE(sat) | | | 0.8 0.9 1.2 1.4 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product(2) (VCE = 20 Vdc, IC = 20 mAdc, f = 100 MHz) | | ÍΤ | 150 | _ | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 100 kHz) | 2N3498, 2N3499 2N3500, 2N3501 | Cobo | _ | = | 10 8.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = 0, f = 100 kHz) | | C _{ibo} | _ | - | 80 | pF |
| Input Impedance (I _C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) | 2N3498, 2N3500 2N3499, 2N3501 | h _{ie} | 0.2 0.25 | = | 1.0 1.25 | k ohms |
| Voltage Feedback Ratio (IC = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | 2N3498, 2N3500 2N3499, 2N3501 | h _{re} | = | = | 2.5 4.0 | X 10-4 |
| Small-Signal Current Gain (IC = 10 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | 2N3498, 2N3500 2N3499, 2N3501 | h _{fe} | 50 75 | = | 300 375 | - |
| Output Admittance (IC = 10 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | 2N3498, 2N3500 2N3499, 2N3501 | h _{oe} | = | = | 100 200 | μmhos |
| SWITCHING CHARACTERISTICS | | | | | • | |
| Delay Time (I _C = 150 mAdc, I _{B1} = 15 mAdc, V _{CC} = 100 Vd | c, V _{BE(off)} = 2.0 Vdc) | td | _ | 20 | | ns |
| Rise Time (I _C = 150 mAdc, I _{B1} = 15 mAdc, V_{CC} = 100 Vd | c, V _{BE(off)} = 2.0 Vdc) | t _r | _ | 35 | _ | ns |
| Storage Time (IC = 150 mAdc, IB1 = IB2 = 15 mAdc, VCC = 1 | 100 Vdc) | t _S | _ | 800 | _ | ns |
| Fall Time (IC = 150 mAdc, $I_{B1} = I_{B2} = 15$ mAdc, $V_{CC} = 1$ | 100 Vdc) | tf | _ | 80 | _ | ns |
| 1) Pulse Test: Pulse Width ≤ 300 µs. Duty Cycle ≤ 2 | 2.0%. | | | | • | |

Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

⁽²⁾ f_T = |h_{fe}| • f_{test}.





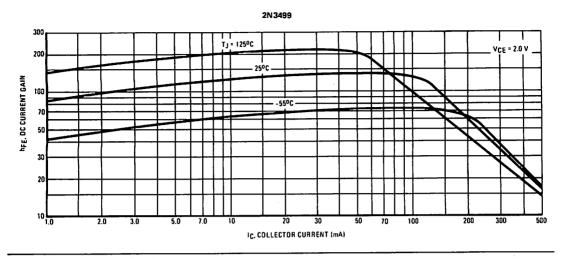
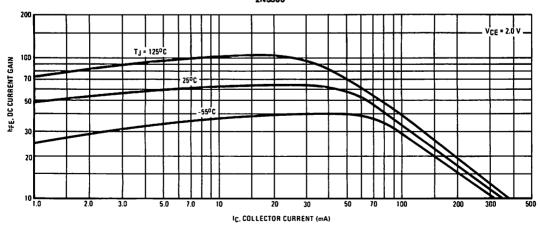
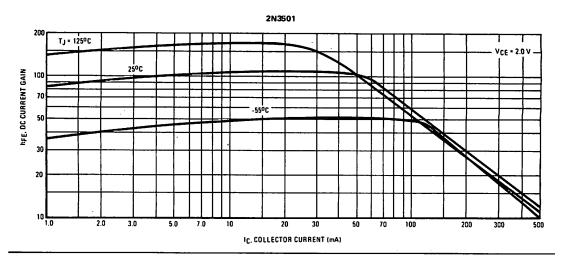
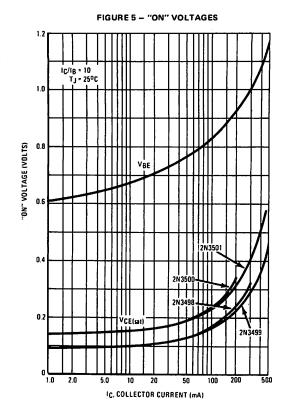
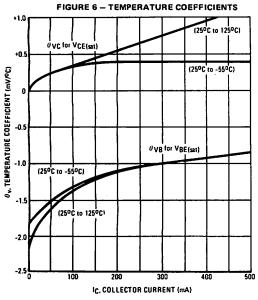


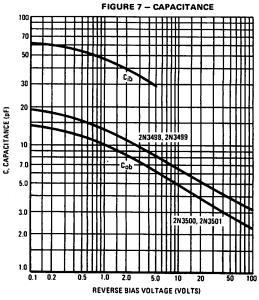
FIGURE 3 — CURRENT GAIN CHARACTERISTICS versus JUNCTION TEMPERATURE 2N3500





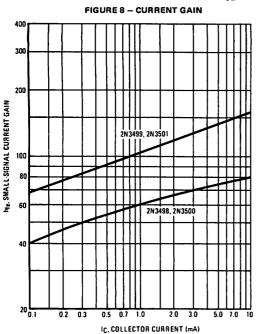


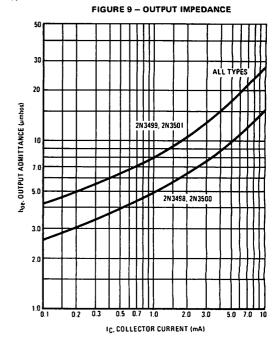


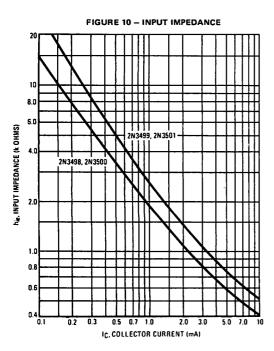


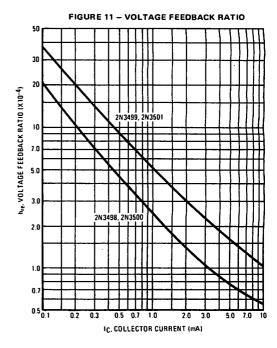
AUDIO SMALL-SIGNAL h PARAMETER CHARACTERISTICS

(VCE = 10 Vdc, TA = 25°C, f = 1.0 kHz)









| Rating | Symbol | 2N3508 | 2N3507 | Unit | | |
|---|----------------------|-------------|--------|----------------|--|-----|
| Collector-Emitter Voltage | VCEO | 40 | 50 | Vdc | | |
| Collector-Base Voltage | VCBO | 60 | 80 | Vdc | | |
| Emitter-Base Voltage | VEBO | 5.0 | | 5.0 | | Vdc |
| Collector Current — Continuous | lc | 3.0 | | Adc | | |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 1.0 5.71 | | Watt mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | | Watts mW/°C | | |
| Operating and Storage Junction Temperature Range | Tj, T _{stg} | -65 to +200 | | °C | | |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|-------------------|-------|-------|
| Thermal Resistance, Junction to Case | R _Ø JC | 0.175 | °C/mW |
| Thermal Resistance, Junction to Ambient | RAIA | 35 | °C/W |

2N3506 2N3507

JAN, JTX, JTXV AVAILABLE CASE 79, STYLE 1 TO-39 (TO-205AD)

SWITCHING TRANSISTOR

NPN SILICON

| Characteristic | | Symbol | Min | Max | Unit |
|--|--|----------------------|----------------------------------|--------------------------|-------------|
| OFF CHARACTERISTICS | | | | , | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, pulsed, Ig = 0) | 2N3506 2N3507 | V(BR)CEO | 40 50 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | 2N3506 2N3507 | V(BR)CBO | 60 80 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 40 Vdc, VEB(off) = 4.0 Vdc) (VCE = 40 Vdc, VEB(off) = 4.0 Vdc, TA = 100°C) (VCE = 60 Vdc, VEB(off) = 4.0 Vdc, (VCE = 60 Vdc, VEB(off) = 4.0 Vdc, TA = 100°C) | 2N3506 2N3507 | ICEX | <u>=</u> = | 1.0 150 1.0 150 | μAdc |
| Base Cutoff Current (V _{CE} = 40 Vdc, V _{EB(off)} = 4.0 Vdc) (V _{CE} = 60 Vdc, V _{EB(off)} = 4.0 Vdc) | 2N3506 2N3507 | IBL | _ | 1.0 1.0 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(1) (IC = 500 mAdc, VCE = 1.0 Vdc) (IC = 1.5 Adc, VCE = 2.0 Vdc) (IC = 2.5 Adc, VCE = 3.0 Vdc) | 2N3506 2N3507 2N3506 2N3507 2N3506 2N3507 | hFE | 50 35 40 30 30 25 | 200 150 — | _ |
| (IC = 3.0 Adc, VCE = 5.0 Vdc) | 2N3506 2N3507 | | 25 20 | | |
| Collector-Emitter Saturation Voltage(1) (I _C = 500 mAdc, I _B = 50 (I _C = 1.5 Adc, I _B = 150 (I _C = 2.5 Adc, I _B = 250 (I _C = 2.5 Adc, | mAdc) | VCE(sat) | | 0.5 1.0 1.5 | Vdc |
| Base-Emitter Saturation Voltage(1) (I _C = 500 mAdc, I _B = 50 mAc (I _C = 1.5 Adc, I _B = 150 mAc (I _C = 2.5 Adc, I _B = 250 mAc | ic) | V _{BE(sat)} | 0.9 — | 1.0 1.4 2.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain - Bandwidth Product (IC = 100 mAdc, VCE = 5 V | dc, f = 20 MHz) | fτ | 60 | - | MHz |

Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)

Input Capacitance ($V_{BE} = 3 \text{ Vdc}$, $I_{C} = 0$, f = 100 kHz)

рF

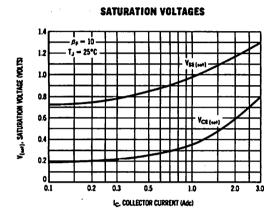
Cobo

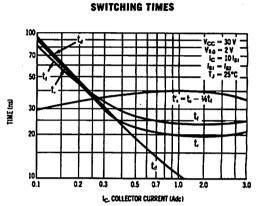
Cibo

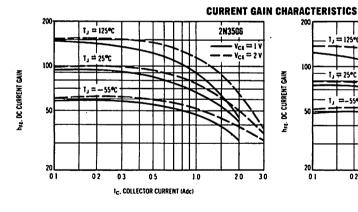
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

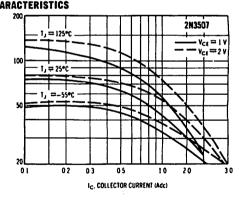
| | Characteristic | Symbol | Min | Max | Unit | | | |
|---------------------------|---|----------------|-----|-----|------|--|--|--|
| SWITCHING CHARACTERISTICS | | | | | | | | |
| Delay Time | IC = 1.5 Adc, IB1 = 150 mAdc | t _d | _ | 15 | ns | | | |
| Rise Time | V _{CC} = 30 V, V _{EB} = 0 V | tr | _ | 30 | ns | | | |
| Storage Time | IC = 1.5 Adc, IB1 = IB2 = 150 mAdc | ts | _ | 55 | ns | | | |
| Fall Time | V _{CC} = 30 V | tf | _ | 35 | ns | | | |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle = 2.0%.









| Rating | Symbol | Value | Unit |
|---|----------------------|--------------|----------------|
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Emitter Voltage | VCES | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | Vdc |
| Collector Current (10 µs pulse) (Peak) | l'C | 500 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.40 2.29 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.0 11.43 | Watts mW/°C |
| Operating and Storage Temperature Temperature Range | TJ, T _{stg} | -65 to +200 | °C |

THERMAL CHARACTERISTICS

| Γ | Characteristic | Symbol | Max | Unit |
|---|---|--------|--------|------|
| Γ | Thermal Resistance, Junction to Case | RøJC | 0.0875 | °C/W |
| ٢ | Thermal Resistance, Junction to Ambient | RAIA | 0.438 | °C/W |

2N3508 2N3509

CASE 26, STYLE 1 TO-46 (TO-206AB)

SWITCHING TRANSISTOR

NPN SILICON

Refer to 2N2368 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|---|--------------------------------|----------------------|--------------|-----------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _B = 0) | | V(BR)CBO | 40 | _ | Vdc |
| Collector-Emitter Breakdown Voltage (1) (IC = 10 mAdc) | | V(BR)CEO | 20 | _ | Vdc |
| Collector-Emitter Voltage (IC = 10 µAdc, IB = 0) | | V(BR)CES | 40 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | | V(BR)EBO | 6.0 | | Vdc |
| Collector Cutoff Current (VCE = 20 Vdc, VEB(off) = 3.0 Vdc) | | ICEX | _ | 0.2 | μAdc |
| Collector Cutoff Current (VCB = 20 Vdc) (VCB = 20 Vdc, TA = 150°C) | Both Types 2N3508 2N3509 | Ісво | = | 0.2 30 50 | μAdc |
| Base Cutoff Current (VCE = 20 Vdc, VEB(off) = 3.0 Vdc) | | IBL | _ | 0.5 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) | 2N3508 2N3509 | pte | 40 100 | 120 300 | _ |
| $(I_C = 10 \text{ mAdc, V}_{CE} = 1.0 \text{ Vdc, T}_A = -55^{\circ}\text{C})$ | 2N3508 2N3509 | | 20 40 | = | |
| (I _C = 100 mAdc, V _{CE} = 1.0 Vdc) | 2N3508 2N3509 | | 20 30 | _ | |
| Collector-Emitter Saturation Voltage (1) (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 100 mAdc, IB = 10 mAdc) | | VCE(sat) | - | 0.25 0.45 | Vdc |
| Base-Emitter Saturation Voltage (1) (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 100 mAdc, I _B = 10 mAdc) | | V _{BE(sat)} | 0.70 0.8 | 0.85 1.4 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | , | |
| Output Capacitance (VCB = 5.0 Vdc, I _E = 0, f = 140 kHz) | | C _{obo} | | 4.0 | pF |

2N3508, 2N3509

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

| | Characteristic | Symbol | Min | Max | Unit |
|---|---|----------------------------------|-----|-----|------|
| Input Capacitance (VBE = 1.0 Vdc, Id | c = 0, f = 140 kHz) | C _{ibo} | _ | 4.0 | pF |
| Small-Signal Curren (IC = 10 mAdc, V | t Gain CE = 10 Vdc, f = 100 MHz) | h _{fe} | 5.0 | _ | _ |
| SWITCHING CHARA | CTERISTICS | | | - | |
| Storage Time (IC = IB1 = IB2 = | = 10 mA) | t _S (τ _S) | _ | 13 | ns |
| Turn-On Time (IC = 10 mA, IB1 | = 3.0 mA, V _{CC} = 3.0 V, V _{OB} = 1.5 V) | ton | _ | 12 | ns |
| Turn-Off Time (IC = 10 mA, IB1 | = 3.0 mA, IB2 = 1.5 mA, VCC = 3.0 V) | toff | _ | 18 | ns |
| Total Control Charge (IC = 10 mA, IB = | e = 1.0 mA, V _{CC} = 3.0 V) | Qт | _ | 50 | рC |
| Delay Time | V _{CC} = 10 V, V _{EB} = 2.0 V, | td | | 5.0 | ns |
| Rise Time | IC = 100 mA, IB1 = 10 mA | t _r | | 18 | ns |
| Storage Time | V _{CC} = 10 V | t _S | _ | 13 | ns |
| Fall Time | IC = 100 mA, IB1 = IB2 = 10 mA | te . | I _ | 15 | ns |

⁽¹⁾ Pulse Test: PW = 300 µs, Duty Cycle ≤ 2.0%.

| WAXINOW RATINGS | | | | | | | | |
|---|----------------------|---------------------------|---------------------------|----------------|--|-----|--|------|
| Rating | Symbol | 2N3510 2N3647 | 2N3511 2N3648 | Unit | | | | |
| Collector-Emitter Voltage | VCEO | 10 | 15 | Vdc | | | | |
| Collector-Base Voltage | VCBO | 40 | 40 | Vdc | | | | |
| Emitter-Base Voltage | VEBO | 6.0 | | Vdc | | | | |
| Collector Current — Continuous | lc . | 500 | | 500 | | 500 | | mAdc |
| | | TO-46 2N3647 2N3648 | TO-52 2N3510 2N3511 | | | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 400 2.28 | 360 2.06 | mW mW/°C | | | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.0 11.43 | 1.2 6.9 | Watts mW/°C | | | | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | | °C | | | | |

2N3510 2N3511

CASE 27, STYLE 1 TO-52 (TO-206AC)

2N3647 2N3648

CASE 26, STYLE 1 TO-46 (TO-206AB)

SWITCHING TRANSISTOR

NPN SILICON

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

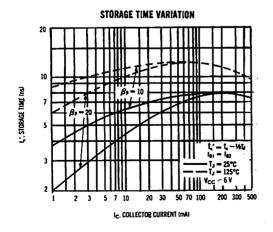
| Characteristic | | Symbol | Min | Max | Unit |
|--|--|----------|----------------|---------------------------|------|
| OFF CHARACTERISTICS | | | | • | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | 2N3510, 2N3647 2N3511, 2N3648 | V(BR)CEO | 10 15 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | | V(BR)CBO | 40 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | | V(BR)EBO | 6.0 | | Vdc |
| Collector Cutoff Current (VCE = 10 Vdc, VEB(off) = 1.0 Vdc) (VCE = 10 Vdc, VEB(off) = 1.0 Vdc, TA = 150°C) | | ICEX | | .025 50 | μAdc |
| Base Cutoff Current (VCE = 10 Vdc, VOB = 1.0 Vdc) | | IBL | - | .025 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) | 2N3510, 2N3647 2N3511, 2N3648 | hFE | 12 15 | = | _ |
| (IC = 10 mAdc, VCE = 1.0 Vdc) | 2N3510, 2N3647 2N3511, 2N3648 | | 20 25 | = - | |
| (IC = 150 mAdc, VCE = 1.0 Vdc) | 2N3510, 2N3647 2N3511, 2N3648 | | 25 30 | 150 120 | |
| (I _C = 150 mAdc, V _{CE} = 1.0 Vdc, TA = -55°C) (I _C = 300 mAdc, V _{CE} = 1.0 Vdc) (I _C = 500 mAdc, V _{CE} = 1.0 Vdc) | 2N3511, 2N3648 2N3510, 2N3647 2N3511, 2N3648 | : | 12 15 12 | = | |
| Collector-Emitter Saturation Voltage(1) (IC = 10 mAdc, Ig = 1.0 mAdc) (IC = 150 mAdc, Ig = 15 mAdc) (IC = 300 mAdc, Ig = 30 mAdc) (IC = 500 mAdc, Ig = 60 mAdc) | 2N3510, 2N3647 2N3511, 2N3648 | VCE(sat) | = | 0.25 0.4 0.6 0.8 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 10 mAdc, Ig = 1.0 mAdc) (IC = 150 mAdc, Ig = 15 mAdc) (IC = 300 mAdc, Ig = 30 mAdc) (IC = 500 mAdc, Ig = 50 mAdc) | 2N3510, 2N3647 2N3511, 2N3648 | VBE(sat) | 0.8 — | 0.8 1.0 1.15 1.5 | Vdc |

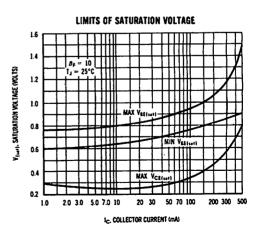
2N3510, 2N3511 / 2N3647, 2N3648

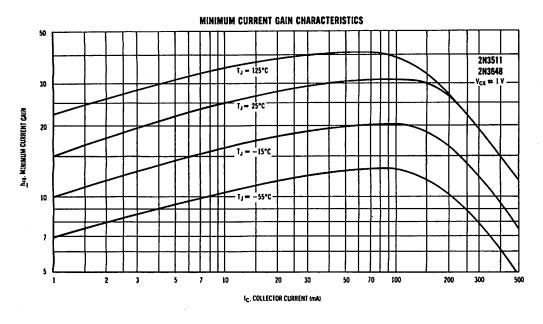
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

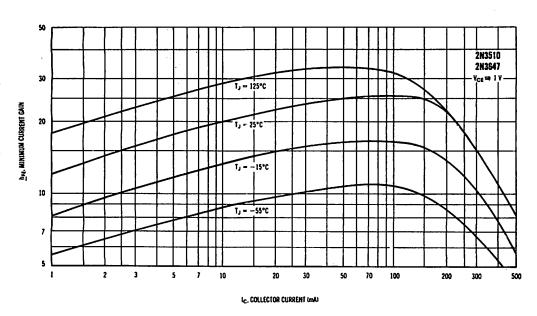
| Characteristic | | Symbol | Min | Max | Unit | |
|--|---|----------------------------------|------------------|------------------|-------------|--------|
| SMALL-SIGNAL CHAR | ACTERISTICS | | - | | | |
| Output Capacitance (VCB = 10 Vdc, IE = | 0, f = 100 kHz) | | Copo | 1 | 4.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = | 0, f = 100 kHz) | | C _{ibo} | 1 | 8.0 | pF |
| Input Impedance (IC = 1.0 mA, VCE = | 10 V, f = 1.0 kHz) | | hie | 0.6 | 4.5 | kohms |
| Voltage Feedback Ratio | | | h _{re} | - | 25 | X 10-4 |
| Small-Signal Current G (IC = 15 mAdc, VCE) (IC = 1.0 mA, VCE = | = 10 Vdc, f = 100 MHz) | 2N3510, 2N3647 2N3511, 2N3648 | h _{fe} | 3.5 4.5 20 | 150 | _ |
| Output Admittance | 10 V, f = 1.0 kHz) | <u> </u> | h _{oe} | 10 | 100 | μmhos |
| SWITCHING CHARACT | ERISTICS | | | | | |
| Delay Time | (I _C = 150 mA, I _{B1} = 15 mA, V _{EB} = 0.5 V, V _{CC} = 6.0 V) | 2N3510, 2N3647 2N3511, 2N3648 | ^t d | = | 10 8.0 | ns |
| Rise Time | | 2N3510, 2N3647 2N3511, 2N3648 | t _r | = | 12 10 | ns |
| Storage Time | (I _C = 150 mA, I _{B1} = -I _{B2} = 15 mA, V _{CC} = 6.0 V) | 2N3510, 2N3647 2N3511, 2N3648 | ts | _ | 16 12 | ns |
| Fall Time | 1 | 2N3510, 2N3647 2N3511, 2N3648 | tf | = | 12 8.0 | ns |
| Turn-On Time | (IC = 150 mA, IB1 = 15 mA, VEB = 0.5 V, VCC = 6.0 V) | 2N3510, 2N3647 2N3511, 2N3648 | ton | = | 20 16 | ns |
| Turn-Off Time | (I _C = 150 mA, I _{B1} = -I _{B2} = 15 mA, V _{CC} = 6.0 V) | 2N3510, 2N3647 2N3511, 2N3648 | toff | _ | 25 18 | . ns |
| Total Control Charge | 15 mA, V _{CC} = 6.0 V) | | От | _ | 300 | рС |

(1) Pulse Test: PW ≤ 300 µs, Duty Cycle ≤ 2.0%.









CASE 22-03, STYLE 1 TO-18 (TO-206AA)

SWITCHING TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| MAXIMOM NATINGS | | | |
|---|-----------------------------------|--------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 12 | Vdc |
| Collector-Base Voltage | VCBO | 15 | Vdc |
| Emitter-Base Voltage | VEBO | 4.5 | Vdc |
| DC Collector Current | lc | 200 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.36 2.06 | Watt mW/℃ |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 6.9 | Watts mW/°C |
| Operating and Storage Temperature Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|------|------|
| Thermal Resistance, Junction to Case | Resc | 0.15 | °C/W |
| Thermal Resistance, Junction to Ambient | RAJA | 0.49 | °C/W |

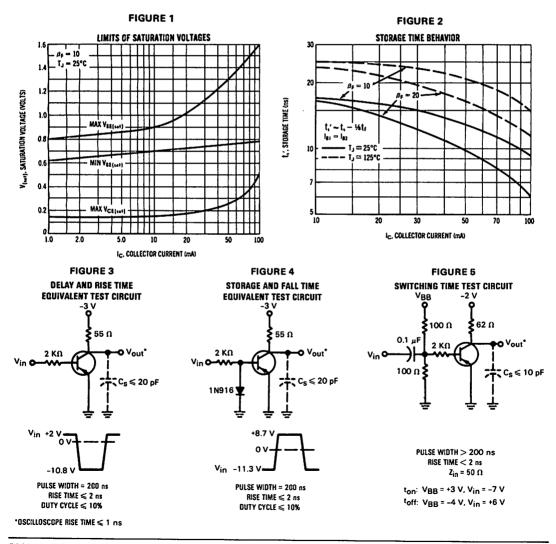
ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

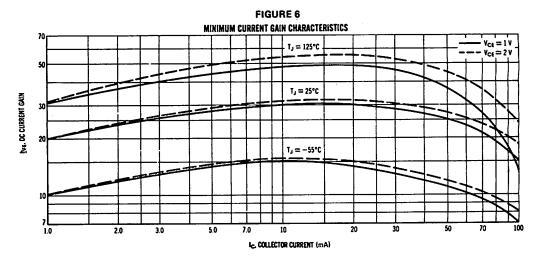
| Characteristic | Symbol | Min | Max | Unit |
|--|------------------|----------------------------|---|---------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (1) (IC = 10 mAdc, IB = 0) | V(BR)CEO | 12 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | V(BR)CBO | 15 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 4.5 | _ | Vdc |
| Base Cutoff Current (VCE = 10 Vdc, VBE(off) = 3.0 Vdc) | IBEV | | 0.10 | μAdc |
| Collector Cutoff Current (VCE = 10 Vdc, VBE(off) = 3.0 Vdc) | ICEX | | 0.010 | μAdc |
| Collector Cutoff Current (V _{CB} = 10 Vdc) (V _{CB} = 10 Vdc, T _A = 150°C) | Ісво | - | 0.010 10 | μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (1) (IC = 1.0 mAdc, VCE = 1.0 Vdc) (IC = 10 mAdc, VCE = 1.0 Vdc) (IC = 10 mAdc, VCE = 1.0 Vdc, TA = -55°C) (IC = 50 mAdc, VCE = 1.0 Vdc) (IC = 100 mAdc, VCE = 1.0 Vdc) (IC = 100 mAdc, VCE = 1.0 Vdc) Collector-Emitter Saturation Voltage (1) (IC = 50 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc) | VCE(sat) | 20 30 15 25 15 | 120 — — — — 0.15 0.25 | Vdc |
| (I _C = 100 mAdc, I _B = 10 mAdc) Base-Emitter Saturation Voltage (1) (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc) (I _C = 100 mAdc, I _B = 10 mAdc) | VBE(sat) | 0.7 0.8 — | 0.50 0.9 1.3 1.6 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 10 Vdc, f = 100 MHz) | fT | 700 | _ | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | - | 6.0 | pF |
| Input Capacitance (V _{BE} = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | C _{ibo} | _ | 5.0 | pF |

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| | Characteristic | Symbol | Min | Max | Unit |
|--|--|-----------------|-----|-----|------|
| SWITCHING CHARA | CTERISTICS | | | | |
| Delay Time | IC = 50 mA, IB1 = 5 .0 mA | td | _ | 10 | ns |
| Rise Time | V _{BE} = 2.0 V, V _{CC} = 3.0 V | tr | _ | 15 | ns |
| Storage Time | IC = 50 mA, IB1 = IB2 = 5.0 mA | ts | _ | 20 | ns |
| Fall Time | V _{CC} = 3.0 V | tf | _ | 15 | กร |
| Turn-On Time | | t _{on} | | 40 | ns |
| Turn-Off Time | | toff | | 30 | ns |
| Total Control Charge (IC = 50 mA, IB == | 5.0 mA, V _{CC} = 3.0 V) | QT | _ | 400 | pC |

⁽¹⁾ Pulse Test: PW = 300 μ s, Duty Cycle \leq 2.0%.





2N3634 2N3636 2N3637 Symbol 2N3635 Unit Rating 140 175 Vdc **VCEO** Collector-Emitter Voltage 140 175 Vdc **V**СВО Collector-Base Voltage Vdc 5.0 Emitter-Base Voltage **VEBO** 1.0 Adc Collector Current — Continuous 1C Watt 1.0 Total Device Dissipation @ TA = 25°C P_D Derate above 25°C 5.71 mW/°C Watts 5.0 Total Device Dissipation @ T_C = 25°C P_{D} 28.6 mW/°C Derate above 25℃ °C Operating and Storage Junction T_J, T_{stg} -65 to +200 Temperature Range

2N3634 thru 2N3637

JAN, JTX AVAILABLE CASE 79, STYLE 1 TO-39 (TO-39-205AD)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

| Cheracteristic | | Symbol | Min | Max | Unit |
|---|----------------------------------|----------------------|------------|----------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | 2N3634, 2N3635 2N3636, 2N3637 | V(BR)CEO | 140 175 | = | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | 2N3634, 2N3635 2N3636, 2N3637 | V(BR)CBO | 140 175 | = | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 100 Vdc, I _E = 0) | | СВО | - | 100 | nAdd |
| Emitter Cutoff Current (VBE = 3.0 Vdc, I _C = 0) | | l _{EBO} | - | 50 | nAdd |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(1) (I _C = 0.1 mAdc, V _{CE} = 10 Vdc) | 2N3634, 2N3636 2N3635, 2N3637 | hFE | 40 80 | · - | _ |
| $(I_C = 1.0 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})$ | 2N3634, 2N3636 2N3635, 2N3637 | - | 45 90 | _ | |
| (IC = 10 mAdc, VCE = 10 Vdc) | 2N3634, 2N3636 2N3635, 2N3637 | | 50 100 | = | |
| (I _C = 50 mAdc, V _{CE} = 10 Vdc) | 2N3634, 2N3636 2N3635, 2N3637 | | 50 100 | 150 300 | |
| (I _C = 150 mAdc, V _{CE} = 10 Vdc) | 2N3634, 2N3636 2N3635, 2N3637 | | 25 50 | _ | |
| Collector-Emitter Saturation Voltage(1) (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc) | | VCE(sat) | _ | 0.3 0.5 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc) | | V _{BE(sat)} | 0.65 | 0.8 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | • | |
| Current-Gain — Bandwidth Product (VCE = 30 Vdc, IC = 30 mAdc, f = 100 MHz) | 2N3634, 2N3636 2N3635, 2N3637 | ft | 150 200 | _ | MHz |

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

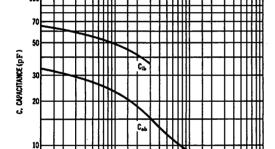
| Characteristic | | Symbol | Min | Max | Unit |
|--|----------------------------------|------------------|------------|-------------|--------|
| Output Capacitance (VCB = 20 Vdc, IE = 0, f = 100 kHz) | | C _{obo} | _ | 10 | pF |
| Input Capacitance (VBE = 1.0 Vdc, IC = 0, f = 100 kHz) | | Cibo | _ | 75 | pF |
| Input Impedance (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | 2N3634, 2N3636 2N3635, 2N3637 | h _{ie} | 100 200 | 600 1200 | ohms |
| Voltage Feedback Ratio (IC = 10 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | | h _{re} | | 3.0 | X 10-4 |
| Small-Signal Current Gain (IC = 10 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | 2N3634, 2N3636 2N3635, 2N3637 | h _{fe} | 40 80 | 160 320 | _ |
| Output Admittance (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | | h _{oe} | | 200 | μmhos |
| Noise Figure (IC = 0.5 mAdc, VCE = 10 Vdc, RS = 1.0 k ohms, | f = 1.0 kHz) | NF | - | 3.0 | dB |

SWITCHING CHARACTERISTICS

0.2 0.3 0.5 0.7 1.0

| Turn-On Time | (V _{CC} = 100 Vdc, V _{BE} = 4.0 Vdc, | ton | _ | 400 | ns |
|---------------|--|------|---|-----|----|
| Turn-Off Time | IC = 50 mAdc, IB1 = IB2 = 5.0 mAdc) | toff | _ | 600 | ns |

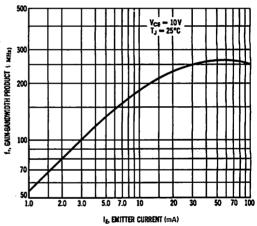
(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.



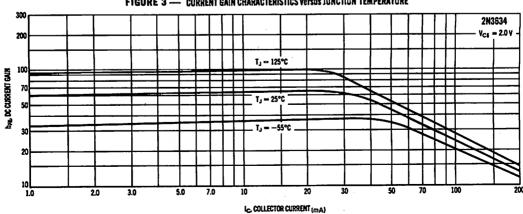
REVERSE BIAS (VOLTS)

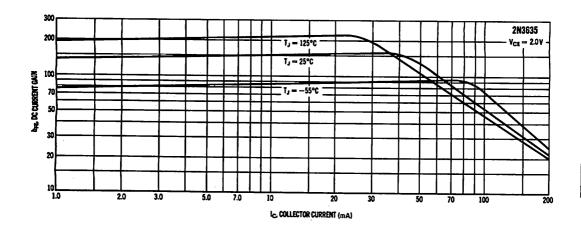
FIGURE 1 — JUNCTION CAPACITANCE VARIATIONS

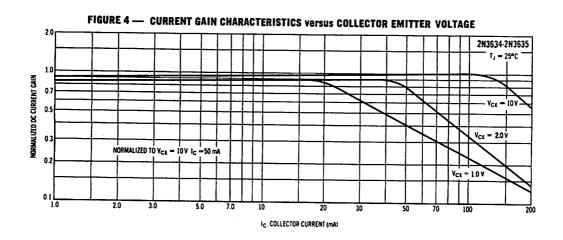
FIGURE 2 — GAIN-BANDWIDTH PRODUCT

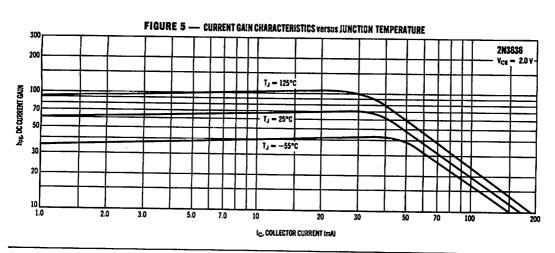














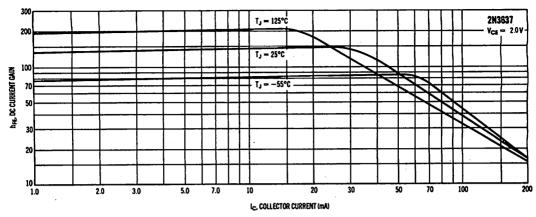
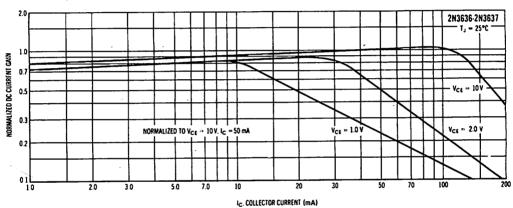
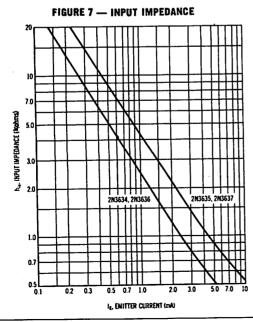
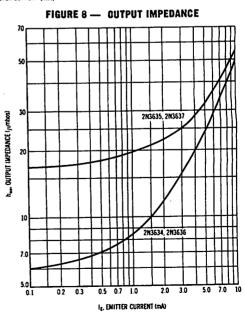


FIGURE 6 — CURRENT GAIN CHARACTERISTICS Versus COLLECTOR EMITTER VOLTAGE









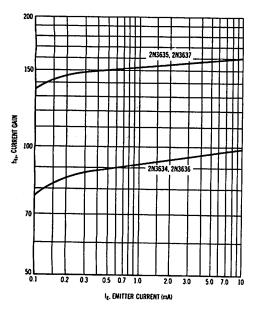


FIGURE 10 - VOLTAGE FEEDBACK RATIO

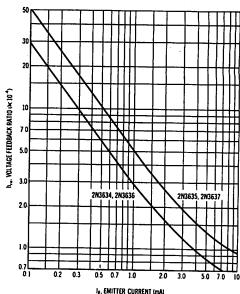


FIGURE 11 — SATURATION VOLTAGES

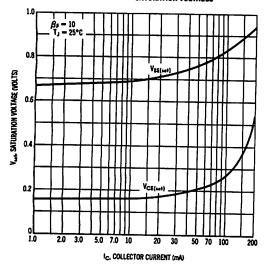


FIGURE 12 - TEMPERATURE COEFFICIENTS

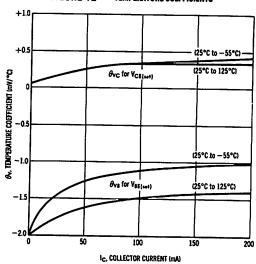
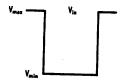


FIGURE 13 — SWITCHING TIME TEST CIRCUIT



P.W. ≈ 20 µ s Duty cycle ≤ 2% Rise time ≤ 20 ps

| | V _{mez} | V _{min} |
|----------|------------------|------------------|
| TURN-ON | +4.0 V | −5.65 V |
| TURN-OFF | +4.1 V | −5.9 V |

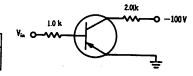


FIGURE 14 — TURN-ON TIME VARIATIONS WITH VOLTAGE

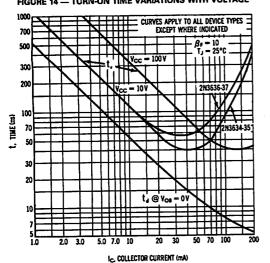
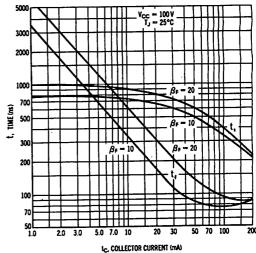


FIGURE 15 — TURN-OFF TIME VARIATIONS WITH CIRCUIT GAIN*



CASE 026-03, STYLE 1 TO-46 (TO-206AB)

LOW POWER CHOPPER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| | т — | | |
|---|----------|-------------|-------------|
| Rating | Symbol | · Value | Unit |
| Collector-Emitter Voltage | VCES | 20 | ٧ |
| Collector-Base Voltage | VCBO | 30 | ٧ |
| Emitter-Base Voltage | VEBO | 30 | V |
| Collector Current — Continuous | ΙC | 100 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 400 2.3 | mW mW/°C |
| Operating and Storage Junction Temperature Range | TJ, Tstg | -65 to +200 | °C |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|--------------|---|------|
| OFF CHARACTERISTICS | | | ' , | · |
| Emitter-Collector Breakdown Voltage (IC = 1.0 nA) | V(BR)ECS | 20 | - | ٧ |
| Collector-Base Breakdown Voltage (IC = 1.0 mA) | V(BR)CBO | 30 | | · V |
| Emitter-Base Breakdown Voltage (Ig = 1.0 mA) | V(BR)EBO | V(BR)EBO 30 | | ٧ |
| Collector Cutoff Current (VCB = 30 V) | 1CBO | _ | 1.0 | nA |
| Emitter Cutoff Current (VEB = 30 V) | IEBO | _ | 1.0 | nA |
| ON CHARACTERISTICS | | · · · · | · | |
| Offset Voltage (Ig = 1.0 mA) | VEC(ofs) | _ | 1.0 | mV |
| Common-Collector static forward transfer ratio (IE = 1.0 mA, VEC = 6.0 V) | h _{fe} | 4.0 | _ | _ |
| On series resistance (Ig = 1.0 mA) | rg | 0.1 | 8.0 | ohms |
| SMALL-SIGNAL CHARACTERISTICS | | | | · |
| Output Capacitance (V _{CB} = 6.0 V, f = 159 kHz) | C _{obo} | - | 10 | ρF |
| Input Capacitance (VEB = 6.0 V, f = 159 kHz) | C _{ibo} | - | 6.0 | pF |
| Magnitude of Forward Current Transfer Ratio, Common-Emitter (I _C = 1.0 mA, V _{CE} = 6.0 V, f = 1.0 MHz) | h _{fe} | 5.0 | _ | |

CASE 79, STYLE 1 TO-39 (205AD)

AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| WARMON DATINGS | | | | | | |
|---|----------------------|-------------|----------------|--|--|--|
| Rating | Symbol | Value | Unit | | | |
| Collector-Emitter Voltage | VCEO | 150 | Vdc | | | |
| Collector-Base Voltage | VCBO | 150 | Vdc | | | |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc | | | |
| Collector Current — Continuous | lc | 200 | mAdc | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.71 | Watts mW/°C | | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | Watts mW/°C | | | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | •€ | | | |

Refer to 2N3498 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|----------|-----------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 30 mAdc, IB = 0) | V(BR)CEO | 150 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μAdc, IE = 0) | V(BR)CBO | 150 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 µAdc, IC = 0) | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 75 Vdc, IE = 0) (VCB = 75 Vdc, IE = 0, TA = 150°C) | ICBO | _ | 0.1 50 | μAdc |
| Emitter Cutoff Current (VBE = 4.0 Vdc, I _C = 0) | (EBO | | 0.1 | μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain(1) (I _C = 10 mAdc, V _{CE} = 10 Vdc) (I _C = 30 mAdc, V _{CE} = 10 Vdc) | hFE | 25 30 | 150 | _ |
| Collector-Emitter Saturation Voltage(1) (IC = 50 mAdc, IB = 5.0 mAdc) | V _{CE(sat)} | _ | 2.0 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 50 mAdc, IB = 5.0 mAdc) | V _{BE(sat)} | _ | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 30 mAdc, VCE = 10 Vdc, f = 20 MHz) | fτ | 40 | 240 | MHz |
| Output Capacitance (VCB = 20 Vdc, IE = 0, f = 1.0 MHz) | C _{obo} | 1.0 | 9.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = 0, f = 1.0 MHz) | C _{ibo} | _ | 80 | pF |
| Small-Signal Current Gain (I _C = 30 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | hfe | 25 | _ | _ |
| Collector Base Time Constant (Ig = 30 mAdc, VCB = 10 Vdc, f = 31.9 MHz) | rb'C _e | - | 100 | ps |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

2N3724 2N3725

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | 2N3724 | 2N3725 | Unit | | |
|---|----------------------|-------------|--------|----------------|--|-----|
| Collector-Emitter Voltage | VCEO | 30 | 50 | Vdc | | |
| Collector-Base Voltage | VCBO | 50 | 80 | Vdc | | |
| Emitter-Base Voltage | VEBO | 6.0 | | 6.0 | | Vdc |
| Collector Current — Continuous | lc | 500 | | mAdc | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.8 4.6 | | Watts mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 3.5 2.0 | | Watts mW/°C | | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | | °C | | |

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|--------------------------------------|----------------------|--|------------------------|--------------------------|------|
| OFF CHARACTERISTICS | | | | | • | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | 2N3725 2N3724 | V(BR)CEO | 50 30 | = | = | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 10 μAdc, VBE = 0) | 2N3725 2N3724 | V(BR)CES | 80 50 | = | = | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 \(\mu \text{Adc}, \) IE = 0) | 2N3725 2N3724 | V(BR)CBO | 80 50 | _ | = | Vdc |
| (I _E = 10 μAdc, I _C = 0) | | V(BR)EBO | 6.0 | _ | _ | Vdc |
| Collector Cutoff Current {VCB = 60 Vdc, Ig = 0} (VCB = 40 Vdc, Ig = 0) {VCB = 60 Vdc, Ig = 0, T _A = 100°C) {VCB = 60 Vdc, Ig = 0, T _A = 100°C) | 2N3725 2N3724 2N3725 2N3724 | ІСВО | | 0.12 0.12 — — | 1.7 1.7 120 120 | μAdc |
| Collector Cutoff Current (VCE = 80 Vdc, VEB = 0) (VCE = 50 Vdc, VEB = 0) | 2N3725 2N3724 | ICES | = | 0.15 0.15 | 10 10 | μAdc |
| Base Current (VCE = 50 V, VEB = 0) (VCE = 80 V, VEB = 0) | 2N3724 2N3725 | lB | _ | _ | 10 | μAdc |
| ON CHARACTERISTICS(1) | | | | | | |
| DC Current Gain {IC = 10 mAdc, VCE = 1.0 Vdc} {IC = 100 mAdc, VCE = 1.0 Vdc, VC = 100 mAdc, VCE = 1.0 Vdc, TA = -55°C) {IC = 100 mAdc, VCE = 1.0 Vdc, TA = -55°C) {IC = 300 mAdc, VCE = 1.0 Vdc, TA = -55°C) {IC = 500 mAdc, VCE = 1.0 Vdc, TA = -55°C) {IC = 800 mAdc, VCE = 2.0 Vdc, TA = -55°C) {IC = 800 mAdc, VCE = 5.0 Vdc) {IC = 800 mA, VCE = 2.0 Vd, VCE = 1.0 Vdc, TA = -55°C) {IC = 1.0 Adc, VCE = 5.0 V} | 2N3725 2N3725 | h₽E | 30 60 30 40 35 20 25 30 20 25 | | | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | 2N3725 2N3724 | V _{BE(sat)} | = | 0.17 0.17 | 0.25 0.25 | Vdc |

2N3724, 2N3725

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|---------|----------------------|-------|------------|------|------|
| · · · · · · · · · · · · · · · · · · · | | | _ | | | |
| $(I_C = 100 \text{ mAdc}, I_B = 10 \text{ mAdc})$ | 2N3725 | 1 | _ | 0.19 | 0.26 | |
| IIC = 100 III 120) IB 10 III 120) | 2N3724 | | | 0.19 | 0.20 | |
| | | | l _ | | | |
| (IC = 300 mAdc, Ig = 30 mAdc) | 2N3725 | | _ | 0.25 | 0.40 | l |
| (IC = 200 HIVAC, IB = 20 HIVAC) | 2N3724 | | | 0.25 | 0.32 | |
| | 2113724 | | l _ | 0.20 | 0.02 | |
| # F00 Ad- 1 F0 Ad-1 | 2N3725 | | | 0.30 | 0.52 | |
| (IC = 500 mAdc, IB = 50 mAdc) | | | l – | 0.30 | 0.52 | |
| | 2N3724 | | | 0.30 | 0.42 | ł |
| | | | l – | | l | ! |
| (IC = 800 mAdc, IB = 80 mAdc) | 2N3725 | | l — | 0.43 | 0.80 | j |
| | 2N3724 | | | 0.43 | 0.65 | l l |
| | | 1 | I — | ŀ | | |
| (IC = 1.0 mAdc, IB = 100 mAdc) | 2N3725 | i i | _ | 0.55 | 0.95 | |
| | 2N3724 | | İ | 0.55 | 0.75 | |
| Base-Emitter Saturation Voltage | | V _{BE(sat)} | | | | Vdc |
| (I _C = 10 mAdc, I _B = 1.0 mAdc) | | DE(301) | l — | l <u> </u> | 0.76 | l |
| (IC = 100 mAde, IB = 10 mAde) | | | l _ | _ | 0.86 | [|
| | | 1 | _ | ۱ ــ | 1.1 | l |
| (IC = 300 mAdc, IB = 30 mAdc) | | 1 | 0.8 | | 1.1 | |
| (IC = 500 mAdc, IB = 50 mAdc) | | | J V.8 | 1 | 1.5 | |
| (IC = 800 mAdc, IB = 80 mAdc) | |] | _ | - | | Į. |
| (IC = 1.0 Adc, IB = 100 mAdc) | | | | <u> </u> | 1.7 | |

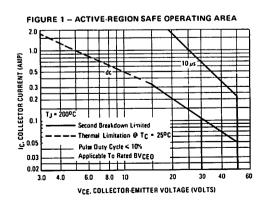
SMALL SIGNAL CHARACTERISTICS

| Current-Gain — Bandwidth Product(2) (IC = 50 mAdc, VCE = 10 Vdc, f = 100 MHz) | | fT | 300 | _ | _ | MHz |
|--|------------------|------------------|-----|---|----------|-----|
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | 2N3725 2N3724 | C _{obo} | = | = | 10 12 | ρF |
| Input Capacitance (VEB = 0.5 Vdc, IC = 0, f = 1.0 MHz) | | Cibo | | _ | 55 | pF |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle = 1.0%.

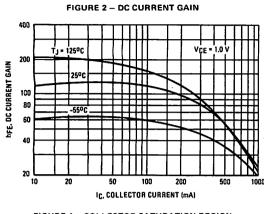
SWITCHING CHARACTERISTICS

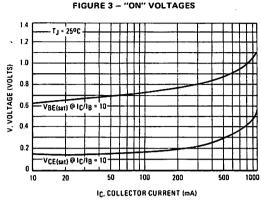
| Delay Time | (VCC = 30 Vdc, VBE(off) = 3.8 Vdc, IC = 500 mAdc, IB1 = 50 mAdc) (Figures 8, 10) | ч | - | 5.0 | 10 | ns |
|---------------|--|----------------|---|-----|----|----|
| Rise Time | | t _r | - | 15 | 30 | ns |
| Turn-On Time | | ton | _ | 20 | 35 | ns |
| Storage Time | (V _{CC} = 30 Vdc, I _C = 500 mAdc, | ts | - | 35 | 50 | ns |
| Fall Time | 1 _{B1} = 1 _{B2} = 50 mAdc) | tf | - | 20 | 25 | ns |
| Turn-Off Time | (Figures 9, 10) | toff | - | 50 | 60 | ns |

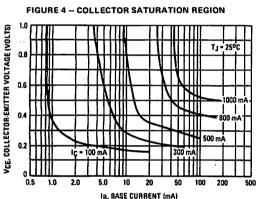


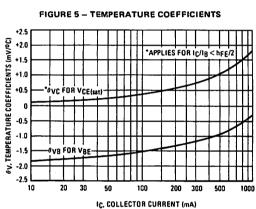
⁽²⁾ f_T = | h_{fe} | • f_{test}.

TYPICAL DC CHARACTERISTICS

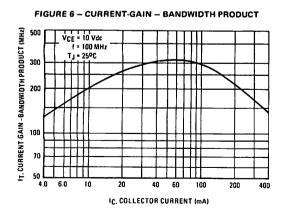


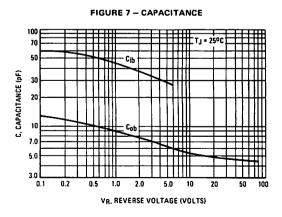


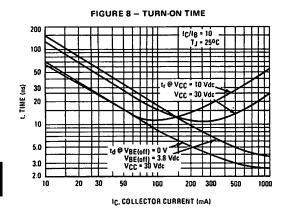




TYPICAL DYNAMIC CHARACTERISTICS







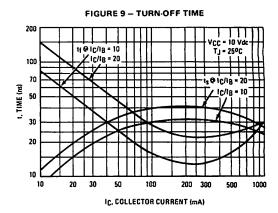
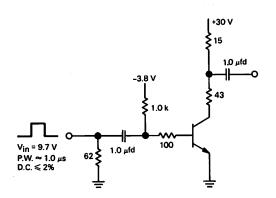
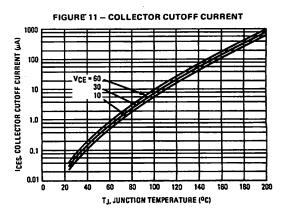


FIGURE 10 - SWITCHING TIME TEST CIRCUIT





MAXIMUM RATINGS

| MANUAL INTUINE | | | | |
|---|----------|---------------------------|---------------------------|----------------|
| Rating | Symbol | 2N3734 2N3736 | 2N3735 2N3737 | Unit |
| Collector-Emitter Voltage | VCEO | 30 | 50 | Vdc |
| Collector-Base Voltage | VCBO | 50 | 75 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc |
| Collector Current — Continuous | lc | 1 | Adc | |
| | | TO-39 2N3734 2N3735 | TO-46 2N3736 2N3737 | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.71 | 0.5 2.86 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 4.0 22.8 | 2.0 11.4 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, Tstg | -65 to +200 | | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | 2N3734 2N3736 | | Unit |
|---|--------|------------------|-------|-------|
| Thermal Resistance, Junction to Case | Rajc | 0.044 | 0.088 | °C/mW |
| Thermal Resistance, Junction to Ambient | Roia | 0.175 | 0.35 | °C/mW |

2N3734 2N3735

CASE 79, STYLE 1 TO-39 (TO-205AD)

2N3736 2N3737

CASE 26, STYLE 1 TO-46 (TO-206AD)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to 2N3725 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|----------------------------------|----------------------|----------------------------|--------------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | 2N3734, 2N3736 2N3735, 2N3737 | V(BR)CEO | 30 50 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 μAdc, IE = 0) | 2N3734, 2N3736 2N3735, 2N3737 | V(BR)CBO | 50 75 | = | Vdc |
| (I _E = 10 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 25 Vdc, VEB = 2 Vdc) (VCE = 25 Vdc, VEB = 2 Vdc, TA = 100°C) (VCE = 40 Vdc, VEB = 2 Vdc, TA = 100°C) (VCE = 40 Vdc, VEB = 2 Vdc, TA = 100°C) | 2N3734, 2N3736 2N3735, 2N3737 | ICEX | = | 0.20 20 0.20 20 | μAdc |
| Base Cutoff Current (VCE = 25 Vdc, VEB = 2 Vdc) (VCE = 40 Vdc, VEB = 2 Vdc) | 2N3734, 2N3736 2N3735, 2N3737 | IBL | | 0.3 0.3 | μAdc |
| ON CHARACTERISTICS | | | | γ | |
| DC Current Gain(1) (IC = 10 mAdc, V _{CE} = 1 Vdc) (IC = 150 mAdc, V _{CE} = 1 Vdc) (I _C = 500 mAdc, V _{CE} = 1 Vdc) (I _C = 1 Adc, V _{CE} = 1.5 Vdc) | 2N3734, 2N3736 2N3735, 2N3737 | hfE | 35 40 35 30 20 | — — — 120 80 | _ |
| (IC = 1.5 Adc, VCE = 5 Vdc) | 2N3734, 2N3736 2N3735, 2N3737 | | 30 20 | _ | } |
| Collector-Emitter Saturation Voltage(1) (I _C = 10 mAdc, I _B = 1 mAdc) (I _C = 150 mAdc, I _B = 15 mAdc) (I _C = 500 mAdc, I _B = 50 mAdc) (I _C = 1 Adc, I _B = 100 mAdc) | | VCE(sat) | = = | 0.2 0.3 0.5 0.9 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 10 mAdc, IB = 1 mAdc) (IC = 150 mAdc, IB = 15 mAdc) (IC = 500 mAdc, IB = 50 mAdc) (IC = 1 Adc, IB = 100 mAdc) | | V _{BE(sat)} | 0.9 | 0.8 1.0 1.2 1.4 | Vdc |

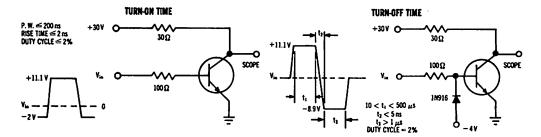
2N3734, 2N3735, 2N3736, 2N3737

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|-----|-----|------|
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Output Capacitance (VCB = 10 Vdc, tg = 0, f = 100 kHz) | C _{obo} | - | 9.0 | pF |
| Input Capacitance (V _{BE} = 0.5 Vdc, I _C = 0, f = 100 kHz) | C _{ibo} | _ | 80 | рF |
| Small-Signal Current Gain (IC = 50 mAdc, VCE = 10 Vdc, f = 100 MHz) | h _{fe} | 2.5 | _ | _ |
| SWITCHING CHARACTERISTICS | | | | |
| Turn-On Time (VCC = 30 V, VBE(off) = 2.0 V, IC = 1.0 Amp, IB1 = 100 mA) | ^t on | _ | 40 | ns |
| Turn-Off Time (VCC = 30 V, VBE(off) = 2.0 V, IC = 1.0 Amp, IB1 = 100 mA) | ^t off | _ | 60 | пѕ |
| Total Control Charge (IC = 1 Amp, IB = 100 mA, VCC = 30 V) | O _r | | 10 | рC |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

SWITCHING TIME EQUIVALENT TEST CIRCUITS



MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 300 | Vdc |
| Collector-Base Voltage | VCBO | 300 | Vdc |
| Emitter-Base Voltage | VEBO | 7.0 | Vdc |
| Collector Current — Continuous | lc | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.71 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

2N3742

CASE 79-02, STYLE 1 TO-39 (TO-205AD) AMPLIFIER TRANSISTOR

NPN SILICON

THERMAL CHARACTERISTICS

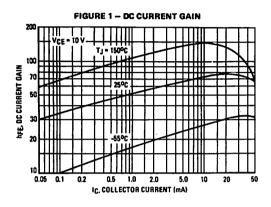
| Characteristic | Symbol | Max | Unit |
|---|--------|-----|------|
| Thermal Resistance, Junction to Case | ReJC | 35 | °C/W |
| Thermal Resistance, Junction to Ambient | RAJA | 175 | °C/W |

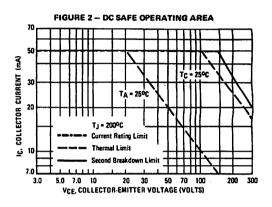
| Characteristic | Symbol | Min | Max | Unit |
|--|---------------------------------------|----------------------|-------------|--------|
| OFF CHARACTERISTICS | | | | - |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | V(BR)CEO | 300 | | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 µAdc, I _E = 0) | V(BR)CBO | 300 | _ | Vdc |
| Emitter-Base Breakdown Voltage (Ig = 100 µAdc, IC = 0) | V(BR)EBO | 7.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 200 Vdc, $I_E = 0$) (VCB = 200 Vdc, $I_E = 0$, $T_A = 100^{\circ}$ C) | Ісво | _ | 0.2 20 | μAdc |
| (VEB = 6.0 Vdc, IC = 0) | IEBO | _ | 0.2 | μAdc |
| ON CHARACTERISTICS(2) | · · · · · · · · · · · · · · · · · · · | | | |
| DC Current Gain (I _C = 3.0 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc) (I _C = 30 mAdc, V _{CE} = 10 Vdc) (I _C = 50 mAdc, V _{CE} = 20 Vdc) | hFE | 10 15 20 20 | 200 | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 30 mAdc, I _B = 3.0 mAdc) | VCE(sat) | = | 0.75 1.0 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 30 mAdc, I _B = 3.0 mAdc) | V _{BE(sat)} | = | 1.0 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | ** |
| Current-Gain — Bandwidth Product(3) (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 20 MHz) | fτ | 30 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | _ | 6.0 | pF |
| Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 100 kHz) | C _{ibo} | _ | 80 | pF |
| Input Impedance (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{ie} | _ | 2.0 | k ohms |
| Voltage Feedback Ratio (IC = 10 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{re} | _ | 2.0 | X10-4 |
| Small-Signal Current Gain (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 10 kHz) | hfe | 20 | 200 | _ |

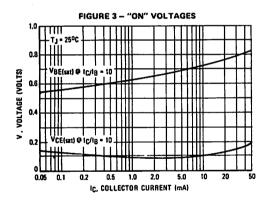
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

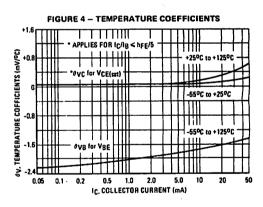
| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|-----|-----|------|
| Output Admittance (IC = 10 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{oe} | - | 50 | mhos |
| Real Part of Input Impedance (IC = 10 mAdc, VCE = 10 Vdc, f = 5.0 MHz) | Re(h _{ie}) | - | 200 | Ohms |

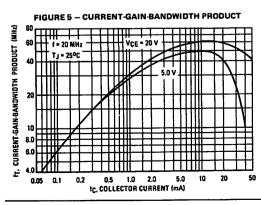
- (1) Pulse Test: Pulse Width ≤ 30 µs, Duty Cycle ≤ 1.0%.
- (2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.
- (3) fT is defined as the frequency at which |hfe| extrapolates to unity.

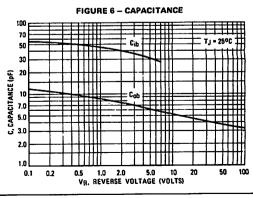












2N3743

JAN, JTX AVAILABLE CASE 79, STYLE 1 TO-39 (TO-205AD)

AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 300 | Vdc |
| Collector-Base Voltage | V _{CBO} | 300 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.7 | Watts mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

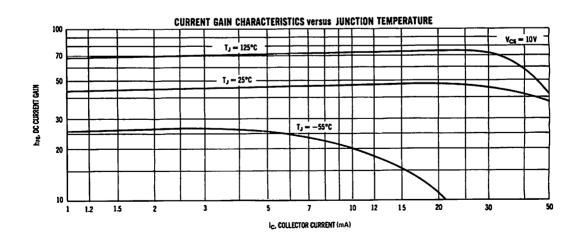
| Characteristic | Symbol | Min | Max | Unit |
|---|-----------------------|----------------------------------|------------|--------|
| OFF CHARACTERISTICS | | - | | • |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | V(BR)CEO | 300 | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V _(BR) CBO | 300 | - | Vdc |
| Emitter-Base Breakdown Voltage (l _E = 100 µAdc, l _C = 0) | V _{(BR)EBO} | 5.0 | | Vdc |
| Collector Cutoff Current (VCB = 200 Vdc, IE = 0) (VCB = 200 Vdc, IE = 0, TA = 100°C) | ІСВО | = | 0.3 30 | μAdc |
| Emitter Cutoff Current (VEB = 3.0 Vdc, IC = 0) | IEBO | | 0.1 | μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain(2) (IC = 100 µAdc, VCE = 10 Vdc) (IC = 1.0 mAdc, VCE = 10 Vdc) (IC = 10 mAdc, VCE = 10 Vdc) (IC = 30 mAdc, VCE = 10 Vdc) (IC = 50 mAdc, VCE = 20 Vdc) | hfE | 20 25 25 25 25 25 | | _ |
| Collector-Emitter Saturation Voltage(2) (IC = 10 mAdc, Ig = 1 mAdc) (IC = 30 mAdc, Ig = 3 mAdc) | V _{CE(sat)} | = | 5.0 8.0 | Vdc |
| Base-Emitter Saturation Voltage(2) (IC = 10 mAdc, I _B = 1 mAdc) (I _C = 30 mAdc, I _B = 3 mAdc) | VBE(sat). | _ | 1.0 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | _ | | |
| Output Capacitance (V _{CB} = 20 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | _ | 15 | ρF |
| Input Cepacitance (VEB = 1.0 Vdc, I_C = 0, f = 100 kHz) | Cibo | _ | 400 | pF |
| Input Impedance (VCE = 10 V, IC = 10 mA, f = 1 kHz) | h _{ie} | _ | 1.0 | kohms |
| Voltage Feedback Ratio {VCE = 10 V, IC = 10 mA, f = 1 kHz} | h _{re} | _ | 4.0 | X 10-4 |
| Small-Signal Current Gain (VCE = 10 V, IC = 10 mA, f = 1 kHz) | h _{fe} | 30 | 300 | _ |

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

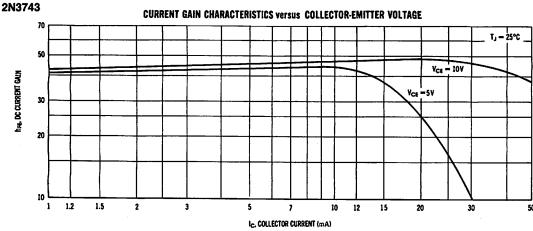
| Characteristic | Symbol | Min | Max | Unit |
|---|----------------------|-----|-----|-------|
| Current Gain — High Frequency (IC = 10 mAdc, VCE = 20 Vdc, f = 20 MHz) | h _{fe} | 1.5 | _ | _ |
| Output Admittance (VCE = 10 V, IC = 10 mA, f = 1 kHz) | h _{oe} | 1 | 200 | μmhos |
| Real Part of Input Impedance (IC = 10 mAdc, VCE = 10 Vdc, f = 5 MHz) | Re(h _{ie}) | 1 | 40 | ohms |

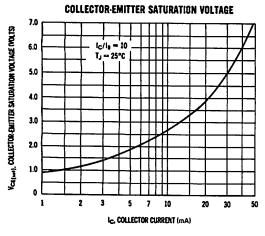
⁽¹⁾ PW ≤ 30 µs, Duty Cycle ≤ 1.0%.

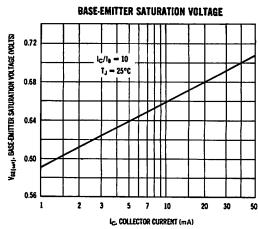
300 200 70 70 70 90 100 REVERSE BUSS (YOUTS)



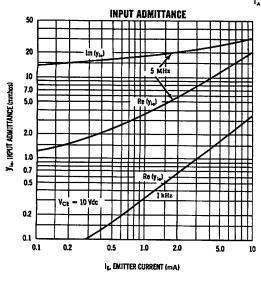
⁽²⁾ PW ≤ 300 µs, Duty Cycle ≤ 2.0%.

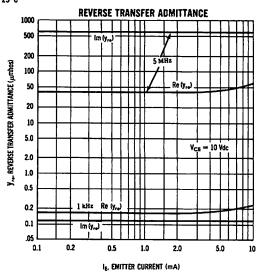


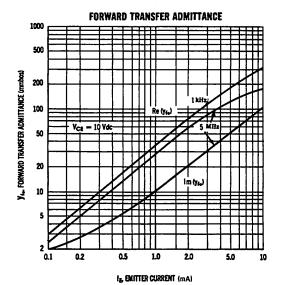


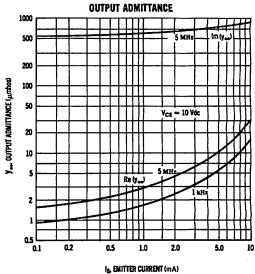


SMALL SIGNAL Y PARAMETERS $T_A = 25$ °C









MAXIMUM RATINGS

| MAXIMUM KATINGS | | | | | | |
|---|-----------------------------------|--------------------------|---------------------------|----------------|--|-----|
| Rating | Symbol | 2N3762 2N3764 | 2N3763 2N3765 | Unit | | |
| Collector-Emitter Voltage | VCEO | 40 | 60 | Vdc | | |
| Collector-Base Voltage | VCBO | 40 | 60 | Vdc | | |
| Emitter-Base Voltage | VEBO | 5 | 5.0 | | | |
| Collector Current — Continuous | lc | 1.5 | | 1.5 | | Adc |
| | | TO-5 2N3762 2N3763 | TO-46 2N3764 2N3765 | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.71 | 0.5 2.86 | Watt mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 4.0 22.8 | 2.0 11.4 | Watts mW/°C | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | °C | | |
| Lead Temperature 1/16" from Case for 10 Seconds | TL | + 235 | | °C | | |

2N3762, 2N3763 2N3764, 2N3765

JAN, JTX, JTXV AVAILABLE CASE 79, CASE 26, STYLE 1 TO-39, TO-46

SWITCHING TRANSISTOR

PNP SILICON

THERMAL CHARACTERISTICS

| Characteristic | Symbol | | 2N3764 2N3765 | Unit |
|---|--------|-----|------------------|------|
| Thermal Resistance, Junction to Case | RAJC | 44 | 88 | °C/W |
| Thermal Resistance, Junction to Ambient | RAIA | 175 | 350 | °C/W |

| Characteristic | | Symbol | Min | Max | Unit |
|--|----------------------------------|----------------------|----------------------------|---------------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, Ig = 0) | 2N3762, 2N3764 2N3763, 2N3765 | V(BR)CEO | 40 60 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 \(\mu \)Adc, IE = 0) | 2N3762, 2N3764 2N3763, 2N3765 | V(BR)CBO | 40 60 | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | | V(BR)EBO | 5.0 | | Vdc |
| Collector Cutoff Current (VCE = 20 Vdc, VEB = 2.0 Vdc) (VCE = 20 Vdc, VEB = 2.0 Vdc, T _A = 100°C) (VCE = 30 Vdc, VEB = 2.0 Vdc) (VCE = 30 Vdc, VEB = 2.0 Vdc, T _A = 100°C) | 2N3762, 2N3764 2N3763, 2N3765 | ICEX | _ _ _ | 0.10 10 0.10 10 | μAdc |
| Base Cutoff Current (VCE = 20 Vdc, VEB = 2.0 Vdc) (VCE = 30 Vdc, VEB = 2.0 Vdc) ON CHARACTERISTICS | 2N3762, 2N3764 2N3763, 2N3765 | IBL | = | 0.2 0.2 | μAdc |
| DC Current Gain(1) (IC = 10 mAdc, VCE = 1.0 Vdc) (IC = 150 mAdc, VCE = 1.0 Vdc) (IC = 500 mAdc, VCE = 1.0 Vdc) (IC = 1.0 Adc, VCE = 1.5 Vdc) | 2N3762, 2N3764 2N3763, 2N3765 | pEE | 35 40 35 30 20 | — — — 120 80 | _ |
| (IC = 1.5 Adc, VCE = 5.0 Vdc) | 2N3762, 2N3764 2N3763, 2N3765 | | 30 20 | - 1 | |
| Collector-Emitter Saturation Voltage(1) C = 10 mAdc, B = 1.0 mAdc) C = 150 mAdc, B = 15 mAdc) C = 500 mAdc, B = 50 mAdc) C = 1.0 Adc, B = 100 mAdc) | | VCE(sat) | | 0.1 0.22 0.5 0.9 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 10 mAdc, Ig = 1.0 mAdc) (IC = 150 mAdc, Ig = 15 mAdc) (IC = 500 mAdc, Ig = 50 mAdc) (IC = 1.0 Adc, Ig = 100 mAdc) | | V _{BE(sat)} | 0.9 | 0.8 1.0 1.2 1.4 | Vdc |

Storage Time

Total Control Charge

Fall Time

2N3762, 2N3763, 2N3764, 2N3765

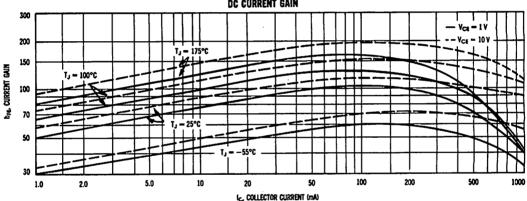
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

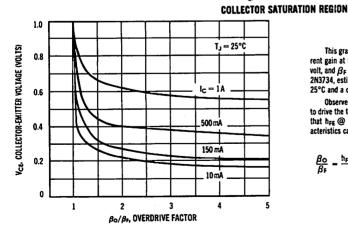
 $(V_{CC} = 30 \text{ V, I}_{C} = 1.0 \text{ Amp,}$ $I_{B1} = -I_{B2} = 100 \text{ mA})$

| Characteristic | | Symbol | Min | Max | Unit |
|--|----------------------------------|------------------|------------|-----|------|
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | | C _{obo} | _ | 15 | рF |
| Input Capacitance (VBE = 0.5 Vdc, IC = 0, f = 100 kHz) | | Cibo | _ | 80 | pF |
| Current Gain — High Frequency (IC = 50 mAdc, VCE = 10 Vdc, f = 100 MHz) | 2N3762, 2N3764 2N3763, 2N3765 | h _{fe} | 1.8 1.5 | = | _ |
| SWITCHING CHARACTERISTICS | | | | | |
| Delay Time (V _{CC} = 30 V, V _{BE(off)} = 2 | .0 V, | ^t d | _ | 8.0 | ns |
| Rise Time IC = 1.0 Amp, IB1 = 100 r | nA) | tr | _ | 3.5 | ns |

⁽IC = 1.0 Amp, IB = 100 mA, V_{CC} = 30 V) (1) Pulse Test: PW \leq 300 μ s, Duty Cycle \leq 2.0%.

"ON" CONDITION CHARACTERISTICS DC CURRENT GAIN





This graph shows the effect of base current on collector current. β_O (current gain at the edge of saturation) is the current gain of the transistor at 1 volt, and β_F (forced gain) is the ratio of I_C/I_{BF} in a circuit. EXAMPLE: For type 2N3734, estimate a base current (I_{BF}) to ensure saturation at a temperature of 25°C and a collector of 500 mA.

80

35

30

ns

ns

рC

ts

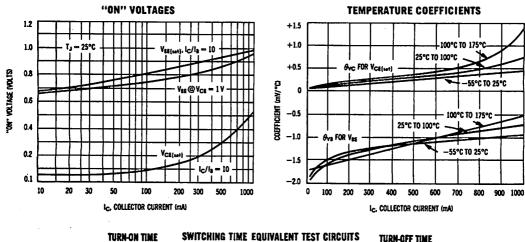
tf

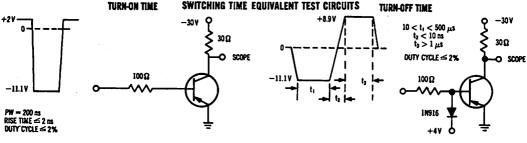
Q,

Observe that at $I_{\rm C}=500\,{\rm mA}$ an overdrive factor of at least 2.0 is required to drive the transistor well into the saturation region. From Figure 1, it is seen that $h_{\rm FE}$ @ 1 volt is typically 54 (guaranteed limits from the Table of Characteristics can be used for "worst-case" design).

$$\frac{\beta_{\rm O}}{\beta_{\rm F}} = \frac{h_{\rm FE} @ 1 \, \rm Volt}{I_{\rm C}/I_{\rm BF}} \qquad 2 = \frac{54}{500 \, \rm mA/I_{\rm BF}} \qquad I_{\rm EF} \sim 18.5 \, \rm mA \, typ$$

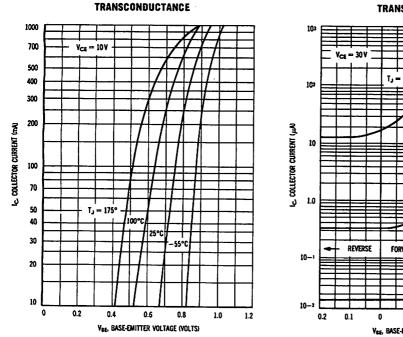
2N3762, 2N3763, 2N3764, 2N3765

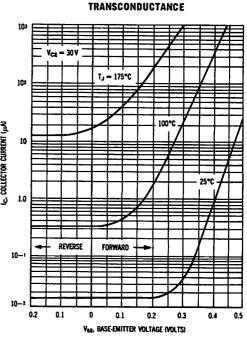


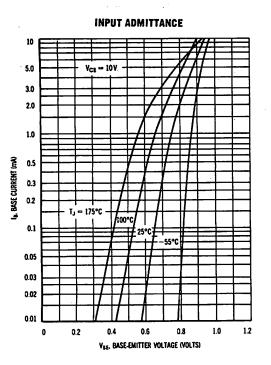


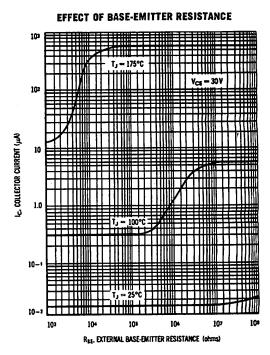
LARGE SIGNAL CHARACTERISTICS

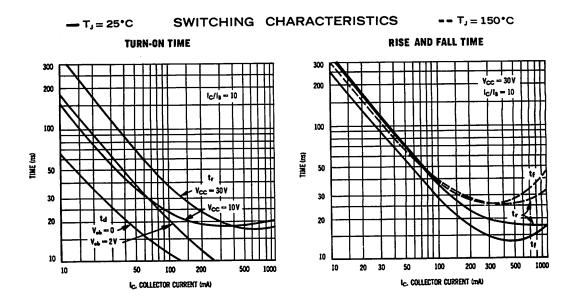
"OFF" CONDITION CHARACTERISTICS

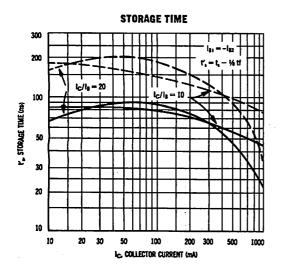


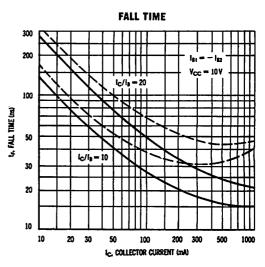


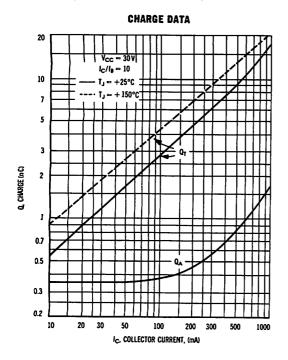


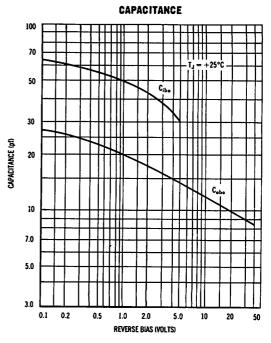




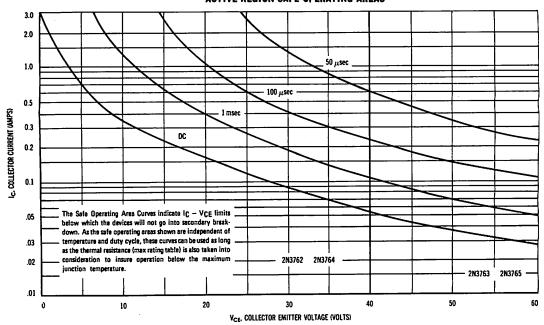








ACTIVE REGION SAFE OPERATING AREAS



MAXIMUM RATINGS

| MD-MINORI ID-THICO | | | | |
|---|----------------------|------------------|--------------------|----------------|
| Rating | Symbol | 2N3798 2N3799 | 2N3798A 2N3799A | Unit |
| Collector-Emitter Voltage | VCEO | 60 | 90 | Vdc |
| Collector-Base Voltage | V _{CBO} | 60 | 90 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc |
| Collector Current — Continuous | lc | 50 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.36 2.06 | | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 6.86 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | Tj, T _{stg} | -65 to +200 | | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|-------|
| Thermal Resistance,-Junction to Case | R _{ØJC} | 0.15 | °C/mW |
| Thermal Resistance, Junction to Ambient | RAIA | 0.49 | °C/mW |

2N3798 2N3799

CASE 22-03, STYLE 1 TO-18 (TO-206AA)

AMPLIFIER TRANSISTOR

PNP SILICON

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|------------------|----------------------|------------|----------|-------------|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 10 mAdc, Ig = 0) | 2N3798, 2N3799 | V(BR)CEO | 60 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 μAdc, IE = 0) | 2N3798, 2N3799 | V(BR)CBO | 60 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | | V _{(BR)EBO} | 5.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) (VCB = 50 Vdc, IE = 0, T_A = 150°C) | | ICBO | _ | | 0.01 10 | μAdc |
| Emitter Cutoff Current (VBE = 4.0 Vdc, IC = 0) | | IEBO | | - | 20 | nAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain(1) (I _C = 1.0 μAdc, V _{CE} = 5.0 Vdc) | 2N3799 | hFE | 75 | _ | _ | _ |
| $(I_C = 10 \mu\text{Adc}, V_{CE} = 5.0 \text{Vdc})$ | 2N3798 2N3799 | | 100 225 | _ | = | |
| $(I_C = 100 \ \mu Adc, V_{CE} = 5.0 \ Vdc)$ | 2N3798 2N3799 | | 150 300 | _ | _ | |
| $(I_C = 100 \ \mu Adc, V_{CE} = 5.0 \ Vdc, T_A = -55^{\circ}C)$ | 2N3798 2N3799 | | 75 150 | = | | |
| (I _C = 500 μAdc, V _{CE} = 5.0 Vdc) | 2N3798 2N3799 | | 150 300 | = | 450 900 | |
| (I _C = 1.0 mAde, V _{CE} = 5.0 Vdc) | 2N3798 2N3799 | | 150 300 | _ | _ | |
| (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) | 2N3798 2N3799 | | 125 250 | | _ | |
| Collector-Emitter Saturation Voltage(1) (I _C = 100 μ Adc, I _B = 10 μ Adc) (I _C = 1.0 mAdc, I _B = 100 μ Adc) | | V _{CE(sat)} | | - | 0.2 0.25 | Vdc |
| Base-Emitter Saturation Voltage(1) (I _C = 100 μAdc, I _B = 10 μAdc) (I _C = 1.0 mAdc, I _B = 100 μAdc) | | V _{BE(sat)} | _ | - 1 | 0.7 0.8 | Vdc |
| Base-Emitter On Voltage (I _C = 100 μAdc, V _{CE} = 5.0 Vdc) | | V _{BE(on)} | _ | - | 0.7 | Vdc |

2N3798, 2N3799

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|------------------|------------------|------------|------------|------------|--------|
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product(2) (I _C = 500 µAdc, V _{CE} = 5.0 Vdc, f = 30 MHz) (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc, f = 100 MHz) | | fτ | 30 100 | _ | _ 500 | MHz |
| Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 100 kHz) | | C _{obo} | - | _ | 4.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = 0, f = 100 kHz) | | C _{ibo} | | 1 | 8.0 | ρF |
| Input Impedance (I _C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) | 2N3798 2N3799 | h _{ie} | 3.0 10 | | 15 40 | k ohms |
| Voltage Feedback Ratio (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | | h _{re} | _ | _ | 25 | X 10-4 |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | 2N3798 2N3799 | h _{fe} | 150 300 | _ | 600 900 | _ |
| Output Admittance (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | | h _{Oe} | 5.0 | _ | 60 | μmhos |
| Noise Figure (I _C = 100 μAdc, V _{CE} = 10 Vdc, R _G = 3.0 k ohms), f = 100 Hz, B.W. = 20 Hz Spot | 2N3798 2N3799 | NF | _ | 4.0 2.5 | 7.0 4.0 | dB |
| f = 1.0 kHz, B.W. = 200 Hz Noise | 2N3798 2N3799 | | = | 1.5 0.8 | 3.0 1.5 | |
| f = 10 kHz, B.W. = 2.0 kHz | 2N3798 2N3799 | | = | 1.0 0.8 | 2.5 1.5 | } |
| Broadband Noise-Bandwidth 10 Hz to 15.7 kHz | 2N3798 2N3799 | | _ | 2.5 1.5 | 3.5 2.5 | |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

SPOT NOISE FIGURE (VCE = 10 Vdc, T_A = 25°C)

FIGURE 1 - SOURCE RESISTANCE EFFECTS, f = 1.0 kHz

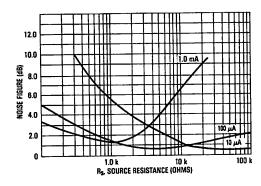
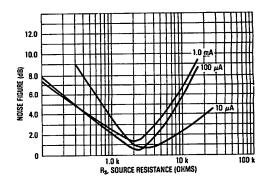


FIGURE 2 — SOURCE RESISTANCE EFFECTS, f = 10 Hz



⁽²⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.

FIGURE 3 — FREQUENCY EFFECTS

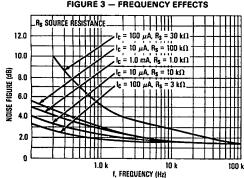


FIGURE 4a - TYPICAL CURRENT **GAIN CHARACTERISTICS-2N3798**

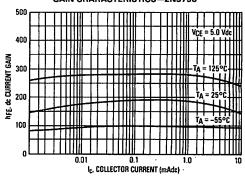
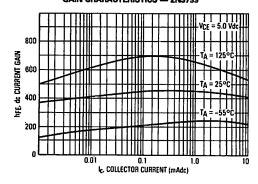


FIGURE 4b — TYPICAL CURRENT **GAIN CHARACTERISTICS — 2N3799**



2N3946 2N3947

CASE 22-03, STYLE 1 TO-18 (TO-206AA)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|-----------------------------------|--------------|----------------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | VCBO | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | Vdc |
| Collector Current — Continuous | lc | 200 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.36 2.06 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 6.9 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|-------|
| Thermal Resistance, Junction to Case | RøJC | 0.15 | °C/mW |
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 0.49 | °C/mW |

| Characteristic | Characteristic | | Min | Max | Unit |
|--|------------------|------------------|------------|-------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc) | | V(BR)CEO | 40 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | | V(BR)CBO | 60 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | | V(BR)EBO | 6.0 | _ | Vdc |
| Collector Cutoff Current (V _{CE} = 40 Vdc, V _{OB} = 3.0 Vdc) (V _{CE} = 40 Vdc, V _{OB} = 3.0 Vdc, T _A = 150°C) | | ICEX | | 0.010 15 | μAdc |
| Base Cutoff Current (VCE = 40 Vdc, VOB = 3.0 Vdc) | | ^I BL | _ | .025 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(1) (I _C = 0.1 mAdc, V _{CE} = 1.0 Vdc) | 2N3946 2N3947 | hFE | 30 60 | = | - |
| (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) | 2N3946 2N3947 | | 45 90 | _ | |
| (IC = 10 mAdc, V _{CE} = 1.0 Vdc) | 2N3946 2N3947 | | 50 100 | 150 300 | |
| (I _C = 50 mAdc, V _{CE} = 1.0 Vdc) | 2N3946 2N3947 | | 20 40 | | |
| Collector-Emitter Saturation Voltage(1) (IC = 10 mAdc, Ig = 1.0 mAdc) (IC = 50 mAdc, Ig = 5.0 mAdc) | | VCE(sat) | | 0.2 0.3 | Vdc |
| Bese-Emitter Saturation Voltage(1) (IC = 10 mAdc, Ig = 1.0 mAdc) (IC = 50 mAdc, Ig = 5.0 mAdc) | | VBE(sat) | 0.6 — | 0.9 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz) | 2N3946 2N3947 | fT | 250 300 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, Ig = 0, f = 100 kHz) | | C _{obo} | _ | 4.0 | pF |

2N3946, 2N3947

ELECTRICAL CHARACTERISTICS (continued) ($T_A = 25^{\circ}C$ unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|---|------------------|-------------------|------------|------------|--------|
| Input Capacitance (VBE = 1.0 Vdc, I _C = 0, f = 100 kHz) | | C _{ibo} | _ | 8.0 | pF |
| | 2N3946 2N3947 | h _{ie} | 0.5 2.0 | 6.0 12 | kohms |
| · · · · · · · · · · · · · · · · · · · | 2N3946 2N3947 | h _{re} | _ | 10 20 | X 10-4 |
| - | 2N3946 2N3947 | h _{fe} | 50 100 | 250 700 | - |
| • | 2N3946 2N3947 | hoe | 1.0 5.0 | 30 50 | μmhos |
| Collector Base Time Constant (I _C = 10 mA, V _{CE} = 20 V, f = 31.8 MHz) | | rb'C _C | _ | 200 | ps |
| Noise Figure . (IC = 100 μ A, VCE = 5.0 V, R _Q = 1.0 k Ω , f = 10 Hz to 15.7 kHz) | | NF | _ | 5.0 | dB |

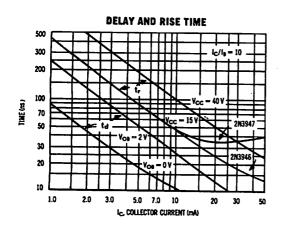
SWITCHING CHARACTERISTICS

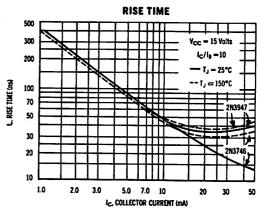
| Delay Time | V _{CC} = 3.0 Vdc, V _{OB} = 0.5 Vdc, | | td | _ | 35 | ns |
|--------------|---|------------------|----|---|------------|----|
| Rise Time | IC = 10 mAdc, IB1 = 1.0 mA | | tr | _ | 35 | ns |
| Storage Time | V _{CC} = 3.0 V, I _C = 10 mA, | 2N3946 2N3947 | ts | _ | 300 375 | ns |
| Fall Time | I _{B1} = I _{B2} = 1.0 mAdc | 2110047 | tf | _ | 75 | ns |

(1) Pulse Test: PW ≤ 300 µs, Duty Cycle ≤ 2%.

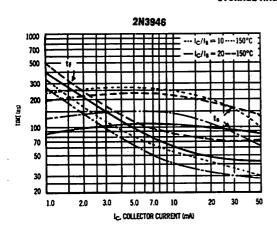
TYPICAL SWITCHING CHARACTERISTICS

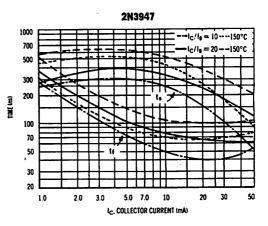
(T_A= 25°C unless otherwise noted)





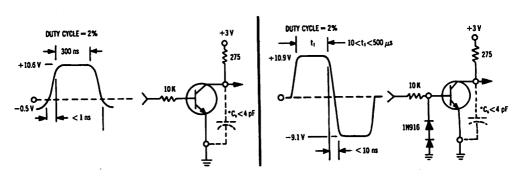
STORAGE AND FALL TIMES





TURN-ON TIME EQUIVALENT TEST CIRCUIT

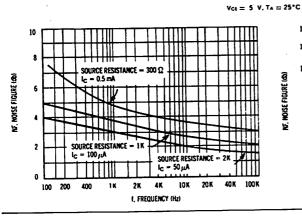
TURN-OFF TIME EQUIVALENT TEST CIRCUIT

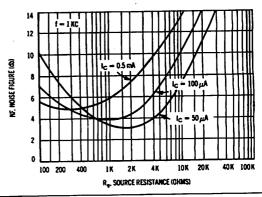


*TOTAL SHURT CAPACITANCE OF TEST JIG AND CORRECTORS

AUDIO SMALL-SIGNAL CHARACTERISTICS

NOISE FIGURE VARIATIONS

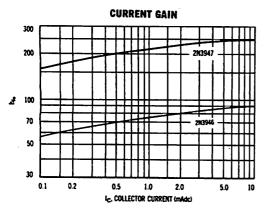


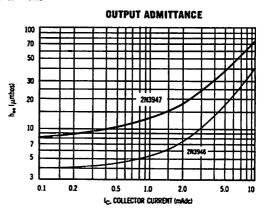


SMALL-SIGNAL DEVICES

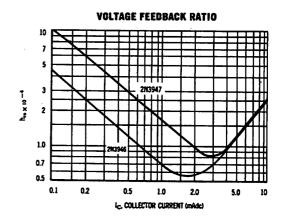
h PARAMETERS

Vct = 10 V. TA = 25°C. f = 1 Kc

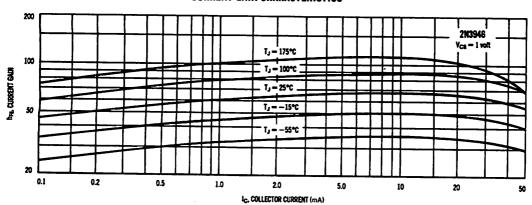


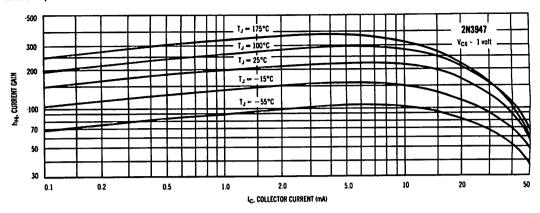


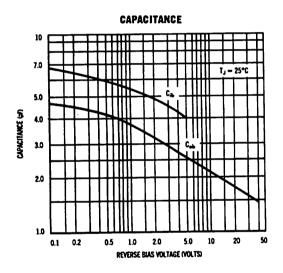
INPUT IMPEDANCE 50 20 10 5.0 2.0 1.0 0.5 0.2 0.1 0.2 0.5 1.0 2.0 5.0 Ic. COLLECTOR CURRENT (mAde)

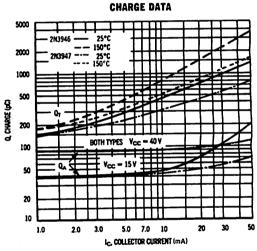


CURRENT GAIN CHARACTERISTICS

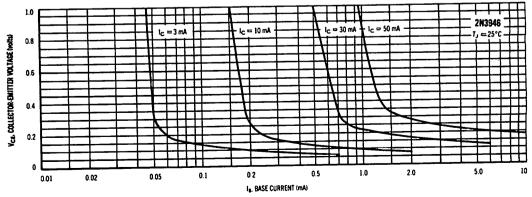




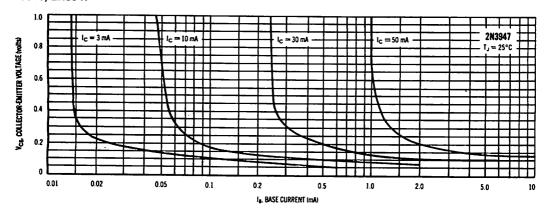


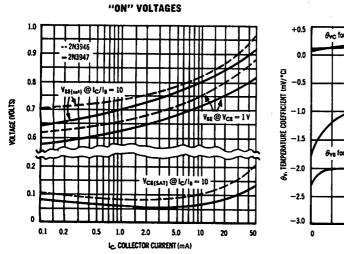


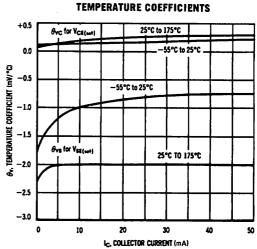
COLLECTOR SATURATION REGION



2N3946, 2N3947







2N3962 2N3963 2N3964 2N3965

CASE 22-03, STYLE 1 TO-18 (TO-206AA)

AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| WARRING WITH THAT WAS | | | | | | | | | | | |
|--|----------------------|------------------|--------|--------|----------------|--|--|-----|--|--|---|
| Rating | Symbol | 2N3962 2N3965 | 2N3964 | 2N3963 | Unit | | | | | | |
| Collector-Emitter Voltage | VCEO | 60 | 45 | 80 | ٧ | | | | | | |
| Collector-Base Voltage | VCBO | 60 | 45 | 80 | ٧ | | | | | | |
| Emitter-Base Voltage | VEBO | 6.0 | | | 6.0 | | | 6.0 | | | V |
| Collector Current — Continuous | lc | 200 | | | 200 | | | mA | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.36 2.06 | | | Watt mW/°C | | | | | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 6.85 | | | Watts mW/°C | | | | | | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | - | °C | | | | | | | | |

Refer to 2N3798 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------------------------|----------|----------------|----------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 5.0 ma) | 2N3962, 2N3965 2N3963 2N3964 | V(BR)CEO | 60 80 45 | | Vdc |
| Collector-Emitter Breakdown Voltage (I _C = 10 μA) | 2N3962, 2N3965 2N3963 2N3964 | V(BR)CES | 60 80 45 | 111 | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µA) | 2N3962, 2N3965 2N3963 2N3964 | V(BR)CBO | 60 80 45 | <u>-</u> - | Vdc |
| Emitter-Base Breakdown Voltage (Ic = 10 μA) | | V(BR)EBO | 6.0 | | Vdc |
| Collector Cutoff Current (VCE = 50 V; 2N3964 = 40 V) (VCE = 70 V) | 2N3965, 2N3962 2N3963 | ICBO | | 10 10 | nAdc |
| Collector Cutoff Current (VCE = 50 V) (VCE = 70 V) (VCE = 40 V) (VCE = 50 V) | 2N3962 2N3963 2N3964 2N3965 | ICES | _ _ _ | 10 10 10 10 | nAdc |
| Emitter Cutoff Current (VEB = 4.0 V) | | IEBO | _ | 10 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(1) (IC = 10 μ A, VCE = 5.0 V) | 2N3962, 2N3963 2N3964, 2N3965 | hFE | 100 250 | 300 500 | _ |
| $(I_C = 100 \ \mu\text{A}, V_{CE} = 5.0 \ \text{V})$ | 2N3962, 2N3963 2N3964, 2N3965 | | 100 250 | = | |
| (IC = 1.0 mA, VCE = 5.0) | 2N3962, 2N3963 2N3964, 2N3965 | | 100 250 | 450 600 | 1 |
| $(I_C = 10 \mu A, V_{CE} = 5.0, T_A = -55^{\circ}C)$ | 2N3962, 2N3963 2N3964, 2N3965 | | 40 100 | | |

2N3962, 2N3963, 2N3964, 2N3965

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | - 25 C dilless otherwise not | Symbol | Min | Max | Unit |
|---|---|----------------------|--------------|------------|-------|
| | | - Symbol | 141111 | | Ont |
| (I _C = 1.0 mA, V _{CE} = 5.0 V, T _A = 100°C) | 2N3962, 2N3963 2N3964, 2N3965 | | = | 600 800 | |
| (I _C = 1.0 μA, V _{CE} = 5.0 V) | 2N3962, 2N3963 2N3964, 2N3965 | | 60 180 | = | |
| (I _C = 10 mA, V _{CE} = 5.0 V) | 2N3962, 2N3963 2N3964, 2N3965 | | 100 200 | _ | |
| (IC = 50 mA, VCE = 5.0 V) | 2N3962, 2N3963 2N3964, 2N3965 | | 90 180 | | |
| (I _C = 50 mA, V _{CE} = 5.0 V, T _A = -56°C) | 2N3962, 2N3963 2N3964, 2N3965 | | 45 90 | _ | |
| Collector-Emitter Saturation Voltage (IC = 10 mA, IB = 0.5 mA) (IC = 50 mA, IB = 5.0 mA)(1) | | V _{CE(sat)} | - | 0.25 | v |
| Base-Emitter Saturation Voltage (IC = 10 mA, IB = 0.5 mA) | | V _{BE(sat)} | - <u>-</u> | 0.4 | v |
| (IC = 50 mA, IB = 5.0 mA)(1) | | | _ | 0.95 | ľ |
| SMALL-SIGNAL CHARACTERISTICS | | | | · | |
| Output Capacitance (VCB = 5.0 V, f = 1.0 MHz) | - | C _{obo} | _ | 6.0 | pF |
| Input Capacitance (VEB = 0.5 V, f = 1.0 MHz) | | C _{ibo} | _ | 15 | pF |
| trput Impedance (IC = 1.0 mA, VCE = 5.0 V, f = 1.0 kHz) | 2N3962, 2N3963 2N3964, 2N3965 | h _{ie} | 2.5 6.0 | 17 20 | kΩ |
| Voltage Feedback Ratio (IC = 1.0 mA, VCE = 5.0, f = 1.0 kHz) | | h _{re} | _ | 10 | 10-4 |
| Small-Signal Current Gain (IC = 1.0 mA, VCE = 5.0 V, f = 1.0 kHz) | 2N3962, 2N3963 2N3964, 2N3965 | h _{fe} | 100 250 | 550 700 | _ |
| Magnitude of Forward Current Transfer Ratio, Commo (IC = 0.5 mA, VCE = 5.0 V, f = 200 MHz) | n-Emitter 2N3962, 2N3963 2N3964, 2N3965 | h _{fe} | 2.0 2.5 | 8.0 8.0 | _ |
| Output Admittance (IC = 1.0 mA, VCE = 5.0, f = 1.0 kHz) | 2N3962, 2N3963 2N3964, 2N3965 | h _{oe} | 5.0 5.0 | 40 50 | μmhos |
| Noise Figure (I _C = 20 mA, V _{CE} = 5.0 V, BW = 15.7 kHz) | 2N3962, 2N3963 2N3964, 2N3965 | NF | _ | 3 2 | dB |
| (IC = 20 μ A, VCE = 5.0 V, BW = 1.5 kHz, f = 10 kHz, R _S = 10 k Ω) | 2N3962, 2N3963 2N3964, 2N3965 | | = | 3 2 | |
| (IC = 20 μ A, VCE = 5.0 V, BW = 150 Hz, f = 1.0 kHz, RS = 10 k Ω) | 2N3962, 2N3963 2N3964, 2N3965 | | = | 3 2 | F - F |
| $(I_C = 20 \ \mu\text{A}, \ V_{CE} = 5.0 \ \text{V}, \ \text{BW} = 15 \ \text{Hz}, \ \text{f} = 100 \ \text{Hz}, \ \text{R}_S = 10 \ \text{k}\Omega)$ | 2N3962, 2N3963 2N3964, 2N3965 | | _ | 10 4 | |
| (IC = 20 μ A, V _{CE} = 5.0 V, BW = 2.0 Hz, f = 10 Hz, R _S = 10 k Ω) | 2N3964, 2N3965 | | _ | 8 | |
| (1) Pulse Test: PW ≤ 300 µs, Duty Cycle ≤ 2%. | | | | | |

⁽¹⁾ Pulse Test: PW ≤ 300 μs, Duty Cycle ≤ 2%.

2N4013 2N4014

CASE 22, STYLE 1 TO-18 (TO-206AA) SWITCHING TRANSISTOR

NPN SILICON

....

MAXIMUM RATINGS

| maximom tarintoo | | | | | | | | |
|---|-----------------------------------|------------|-----------|----------------|--|-----|--|-----|
| Rating | Symbol | 2N4013 | 2N4014 | Unit | | | | |
| Collector-Emitter Voltage | VCEO | 30 | 50 | Vdc | | | | |
| Collector-Base Voltage | VCBO | 50 | 80 | Vdc | | | | |
| Emitter-Base Voltage | VEBO | 6.0 | | 6.0 | | 6.0 | | Vdc |
| Collector Current — Continuous — Peak | lc | 1.0 2.0 | | Adc | | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1 - | .5 3.6 | Watt mW/°C | | | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1 | .4 .8 | Watts mW/°C | | | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 65 to | +200 | °C | | | | |

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|--------------------------------------|-----------------------|--|-------------------|--------------------------|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | 2N4014 2N4013 | V(BR)CEO | 50 30 | _ | | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 10 µAdc, VBE = 0) | 2N4014 2N4013 | V(BR)CES | 80 50 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 μAdc, IE = 0) | 2N4014 2N4013 | V _(BR) CBO | 80 50 | _ | <u> </u> | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | | V(BR)EBO | 6.0 | - | _ | Vdc |
| Collector Cutoff Current (VCB = 60 Vdc, IE = 0) (VCB = 40 Vdc, IE = 0) (VCB = 60 Vdc, IE = 0, TA = 100°C) (VCB = 40 Vdc, IE = 0, TA = 100°C) | 2N4014 2N4013 2N4014 2N4013 | ICBO | 1111 | 0.12 0.12 — | 1.7 1.7 120 120 | μAdc |
| Collector Cutoff Current (V _{CE} = 80 Vdc, V _{EB} = 0) (V _{CE} = 50 Vdc, V _{EB} = 0) | 2N4014 2N4013 | ICES | _ | 0.15 0.15 | 10 10 | μAdc |
| ON CHARACTERISTICS(1) | | | 1 | | | |
| DC Current Gain (IC = 10 mAdc, V _{CE} = 1.0 Vdc) (IC = 100 mAdc, V _{CE} = 1.0 Vdc) (IC = 100 mAdc, V _{CE} = 1.0 Vdc, T _A = -55°C) (I _C = 300 mAdc, V _{CE} = 1.0 Vdc) (I _C = 500 mAdc, V _{CE} = 1.0 Vdc) (I _C = 500 mAdc, V _{CE} = 1.0 Vdc, T _A = -55°C) (I _C = 800 mAdc, V _{CE} = 2.0 Vdc) | 2N4014 2N4013 | hFE | 30 60 30 40 35 20 20 25 | - | 150 | _ |
| (I _C = 1.0 Adc, V _{CE} = 5.0 Vdc) | 2N4014 2N4013 | | 25 30 | | | |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | 2N4014 2N4013 | VCE(sat) | = | 0.17 0.17 | 0.25 0.25 | Vdc |
| (IC = 100 mAdc, IB = 10 mAdc) | 2N4014 2N4013 | | = | 0.19 0.19 | 0.26 0.20 | |

2N4013, 2N4014

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit | |
|--|---|------------------|------------------|-----------------|------------------|-----------------------------------|-----|
| (I _C = 300 mAdc, I _B = 3 | 30 mAdc) | 2N4014 2N4013 | | _ | 0.25 0.25 | 0.40 0.32 | |
| (IC = 500 mAde, IB = 1 | 50 mAde) | 2N4014 2N4013 | | _ | 0.30 0.30 | 0.52 0.42 | |
| (IC = 800 mAdc, IB = 1 | 80 mAdc) | 2N4014 2N4013 | | = | 0.43 0.43 | 0.80 0.65 | |
| (IC = 1.0 Adc, IB = 100 | mAdc) | 2N4014 2N4013 | | _ | 0.55 0.55 | 0.95 0.75 | |
| Base-Emitter Saturation \((IC = 10 mAdc, IB = 1) \((IC = 100 mAdc, IB = 1) \((IC = 300 mAdc, IB = 1) \((IC = 800 mAdc, IB = 1) \((IC = 1.0 Adc, IB = 10) \) | .0 mÅdc) 10 mAdc) 30 mAdc) 50 mAdc) 80 mAdc) | | VBE(sat) | 0.8 | - - - - | 0.76 0.86 1.1 1.1 1.5 | Vdc |
| SMALL-SIGNAL CHARAC | CTERISTICS | | | | | | |
| Current-Gain — Bandwid (IC = 50 mAdc, VCE = | | | fT | 300 | _ | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0 | , f = 1.0 MHz) | 2N4014 2N4013 | C _{obo} | - | | 10 12 | pF |
| Input Capacitance (VEB = 0.5 Vdc, IC = 0 |), f = 1.0 MHz) | | C _{ibo} | _ | _ | 55 | pF |
| SWITCHING CHARACTE | RISTICS | | * | | | | |
| Delay Time | (VCC = 30 Vdc, VBE(off) = 3.8 Vdc | | td | | 5.0 | 10 | ns |
| Rise Time | IC = 500 mAdc, IB1 = 50 mAdc) (Figures 8, 10) | | tr | | 15 | 30 | ns |
| Storage Time | (V _{CC} = 30 Vdc, I _C = 500 mAdc, | 2N4014 | t _S | _ | 30 | 50 | ns |
| Fall Time | l _{B1} = l _{B2} = 50 mAdc) (Figures 9, 10) | 2N4013 | tf | _ | 20 25 | 25 30 | ns |

(Figures 8, 10)

 $(V_{CC} = 30 \text{ Vdc}, V_{BE(off)} = 3.8 \text{ Vdc},$ $I_{C} = 500 \text{ mAdc}, I_{B1} = 50 \text{ mAdc})$

(VCC = 30 Vdc, IC = 500 mAdc,

IB1 = IB2 = 50 mAdc) (Figures 9, 10)

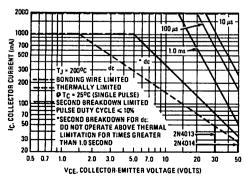
Turn-On Time

Turn-Off Time

FIGURE 1 - ACTIVE-REGION SAFE OPERATING AREA

2N4014

2N4013



20

50

ton

toff

35

60

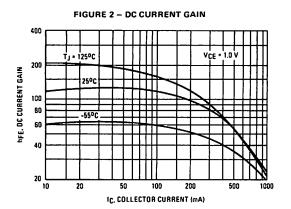
пs

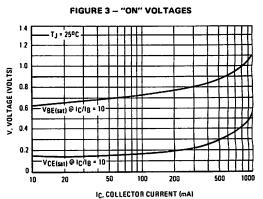
ns

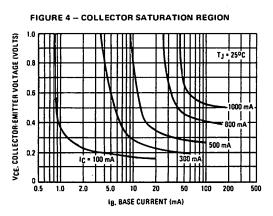
⁽¹⁾ Pulse Test: Pulse Width = 300 μ s, Duty Cycle = 1.0%.

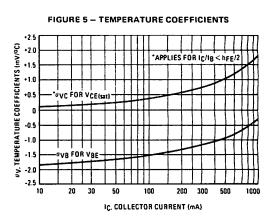
⁽²⁾ fT = |hfe| • ftest.

TYPICAL DC CHARACTERISTICS

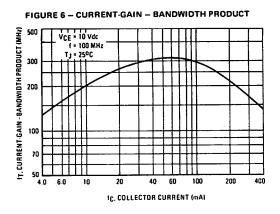








TYPICAL DYNAMIC CHARACTERISTICS



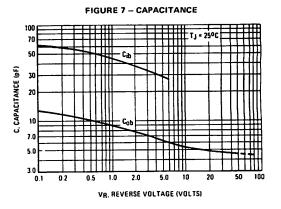
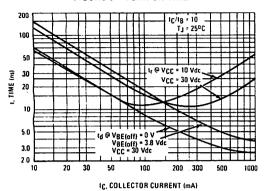


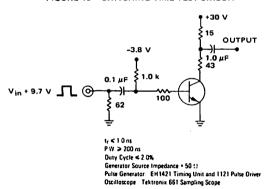
FIGURE 8 - TURN-ON TIME

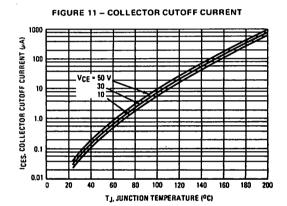


IC, COLLECTOR CURRENT (mA)

FIGURE 9 - TURN-OFF TIME

FIGURE 10 - SWITCHING TIME TEST CIRCUIT





2N4026 thru 2N4033

2N4026-2N4029 CASE 22-03, STYLE 1 TO-18 (TO-206AA)

JAN, JTX, TXV AVAILABLE IN 2N4033 2N4030-2N4033 CASE 79-02, STYLE 1 TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | 2N4026/28 2N4030/32 | 2N4027/29 2N4031/33 | Unit |
|---|----------------------|------------------------|------------------------|------------|
| Collector-Emitter Voltage(1) | VCEO | 60 | 80 | Vdc |
| Collector-Base Voltage | V _{СВО} | 60 | 80 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | 5.0 | Vdc |
| | | 2N4026- 2N4029 | 2N4030- 2N4033 | |
| Collector Current — Continuous | !c | 1.0 | 1.0 | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PĐ | .5 2.85 | 1.25 7.15 | W mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.0 11.4 | 7.0 40 | W mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | | ℃ |
| Lead or Terminal Temperature(2) | ΤL | +; | 300 | °C |

⁽¹⁾ Applicable 0 to 10 mA

THERMAL CHARACTERISTICS

| Characteristic | Symbol | TO-18 | TO-39 | Unit |
|---|--------|-------|-------|------|
| Thermal Resistance, Junction to Case | RAJC | 40 | 20 | °C∕W |
| Thermal Resistance, Junction to Ambient | RAJA | 280 | 140 | °CW |

| Characteristic | | Symbol | Min | Max | Unit |
|---|---|------------------|-----------|----------------|----------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 10 mA) | 2N4026,28,30,32 2N4027,29,31,33 | V(BR)CEO | _ | 60 80 | V |
| Collector-Base Breakdown Voltage (I _C = 10 μA) | 2N4026,28,30,32 2N4027,29,31,33 | V(BR)CBO | _ | 60 80 | V |
| Emitter-Base Breakdown Voltage (I _E = 10 μA) | | V(BR)EBO | - | 5.0 | ٧ |
| Collector Cutoff Current (VCB = 50 V) (VCB = 60 V) (VCB = 50 V, TA = 150°C) | 2N4026,28,30,32 2N4027,29,31,33 2N4026,28,30,32 | ІСВО | = | 50 50 50 | nA μA |
| (V _{CB} = 60 V, T _A = 150°C) Emitter Cutoff Current (V _{EB} = 5.0 V) | 2N4027,29,31,33 | I _{EBO} | _ | 10 | μА |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 100 mA, V _{CE} = 5.0 V, @ -55°C) | 2N4026,27,30,31 2N4028,29,32,33 | hFE | 15 40 | = | _ |
| $(I_C = 100 \ \mu\text{A, V}_{CE} = 5.0 \ \text{V})$ | 2N4026,27,30,31 2N4028,29,32,33 | | 30 75 |] = | |
| $(I_C = 100 \text{ mA, } V_{CE} = 5.0 \text{ V})$ | 2N4026,27,30,31 2N4028,29,32,33 | | 40 100 | 120 300 | |
| $(I_C = 500 \text{ mA, } V_{CE} = 5.0 \text{ V})$ | 2N4026,27,30,31 2N4028,29,32,33 | | 25 70 | = | |
| $(I_C = 1.0 \text{ A, V}_{CE} = 5.0 \text{ V})$ | 2N4026,30 2N4027,31 | | 15 10 | = | |
| (I _C = 1.0 A, V _{CE} = 5.0 V) | 2N4028,32 2N4029,33 | | 40 25 | | |

⁽²⁾ Measured at a distance not less than 1/16" from seated surface (or case) for 60 Sec.

2N4026 thru 2N4033

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|----------|---------------------|------|
| Collector-Emitter Saturation Voltage (I _C = 150 mA, I _B = 15 mA) (I _C = 500 mA, I _B = 50 mA) (I _C = 1.0 A, I _B = 100 mA) 2N4026,28,30,32 | VCE(sat) | <u> </u> | 0.15 0.15 1.0 | v |
| Base-Emitter Saturation Voltage (IC = 150 mA, IB = 15 mA) | V _{BE(sat)} | - | 0.9 | ٧ |
| Base-Emitter On Voltage (I _C = 1.0 A, V _{CE} = 1.0 V) (I _C = 500 mA, V _{CE} = 0.5 V) | V _{BE(on)} | - | 1.2 1.1 | ٧ |
| SMALL-SIGNAL CHARACTERISTICS | | | | - |
| Output Capacitance (VCE = 10 V, f = 1.0 MHz) | Cobo | | 20 | pF |
| Input Capacitance (VEB = 0.5 V, f = 1.0 MHz) | Cibo | _ | 110 | pF |
| Small Signal Current Gain (IC = 50 mA, VCE = 10 V, f = 100 MHz) | h _{fe} | 1.0 | 4.0 | _ |
| SWITCHING CHARACTERISTICS | | | | |
| Storage Time (I _C = 500 mA, I _{B1} = I _{B2} = 50 mA) | t _S | | 350 | ns |
| Turn-On Time (I _C = 500 mA, I _{B1} = 50 mA) | ton | _ | 100 | ns |
| Turn-Off Time (I _C = 500 mA, I _{B1} = I _{B2} = 50 mA) | toff | _ | 50 | ns |

⁽³⁾ Pulse Width = 300 μ s, Duty Cycle 1.0%.

2N4036 2N4037

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | 2N4036 | 2N4037 | Unit |
|---|----------------------|-------------|----------------|----------------|
| Collector-Emitter Voltage | VCEO | 65 | 40 (sus)(1) | Vdc |
| Collector-Base Voltage | V _{CBO} | 90 | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 7.0 | 7.0 | Vdc |
| Base Current | ΙΒ | 0.5 | | Adc |
| Collector Current — Continuous | lc | 1.0 | | Adc |
| Continuous Power Dissipation at or Below T _C = 25°C Linear Derating Factor | PD | 5.0 28.6 | 1.0 5.72 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | | °C |
| Lead Temperature 1/16" from Case for 10 Seconds | ΤL | 230 | | °C |

THERMAL CHARACTERISTICS

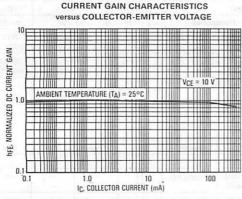
| Characteristic | Symbol | 2N4036 | 2N4037 | Unit |
|--------------------------------------|-------------------|--------|--------|------|
| Thermal Resistance, Junction to Case | R _Ø JC | 25 | _ | °C/W |

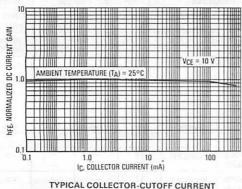
⁽¹⁾ Must not be tested on a curve tracer.

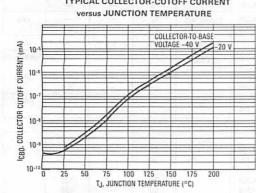
| Characteristic | | Symbol | Min | Max | Unit |
|--|----------------------------|----------------------|----------------|---------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Sustaining Voltage (IC = 100 mAdc, IB = 0) | 2N4036 2N4037 | VCEO(sus) | 65 40 | = | Vdc |
| Collector-Base Breakdown Voltage | 2N4037 | V(BR)CBO | 60 | - | Vdc |
| Collector Cutoff Current (VCE = 85 V, VBE = 1.5 V) (VCE = 30 V, VBE = 1.5 V, TC = 150°C) | 2N4036 | CEX | _ | 100 0.1 | mAdc |
| Collector Cutoff Current (VCB = 90 V, IE = 0) (VCB = 60 V, IE = 0) | 2N4036 2N4037 | ІСВО | _ | 100 0.25 | μAdc |
| Emitter Cutoff Current (VBE = 7.0 Vdc, IC = 0) (VBE = 5.0 Vdc, IC = 0) | 2N4036 2N4037 | !EBO | | 10.0 1.0 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 150 mAdc, V _{CE} = 2.0 V) (I _C = 0.1 mAdc, V _{CE} = 10 V) (I _C = 1.0 mAdc, V _{CE} = 10 V) | 2N4036 2N4036 2N4037 | hFE | 20 20 15 | 200 — — | _ |
| (IC = 150 mAdc, VCE = 10 V) | 2N4036 2N4037 | | 40 50 | 140 250 | |
| (IC = 500 mAdc, VCE = 10 V) | 2N4036 | | 20 | | |
| Collector-Emitter Saturation Voltage (I _C = 150 mA, I _B = 15 mA) | 2N4036 2N4037 | VCE(sat) | | 0.65 1.4 | V |
| Base-Emitter Saturation Voltage (IC = 150 mA, IB = 15 mA) | 2N4036 | V _{BE(sat)} | | 1.4 | ٧ |
| Base-Emitter On Voltage (IC = 150 mA, VCE = 10 V) | 2N4037 | V _{BE(on)} | | 1.5 | V |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Collector-Base Capacitance (VCB = 10 V, f = 1.0 MHz) | 2N4037 | C _{cb} | _ | 30 | pF |
| Current Gain — High Frequency (IC = 50 mA, VCE = 10 V, f = 20 MHz) | 2N4036 2N4037 | h _{fe} | 3.0 3.0 | 10.0 | _ |

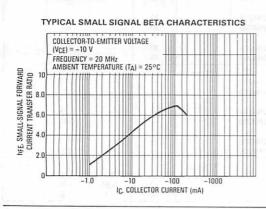
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

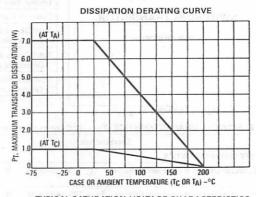
| Characteristic | | Symbol | Min | Max | Unit |
|--|--------|--------|------|-----|------|
| SWITCHING CHARACTERISTICS | | | | | |
| Rise Time (I _{B1} = 15 mA) | 2N4036 | tr | - | 70 | ns |
| Storage Time (I _{B2} = 15 mA) | 2N4036 | ts | - | 600 | ns |
| Fall Time (I _{B2} = 15 mA) | 2N4036 | tf | - na | 100 | ns |
| Turn-On Time $(I_{B1} = I_{B2})$ | 2N4036 | ton | 6247 | 110 | ns |
| Turn-Off Time (I _{B1} = I _{B2}) | 2N4036 | toff | - | 700 | ns |

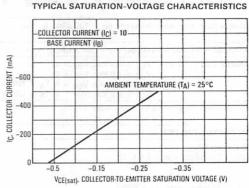


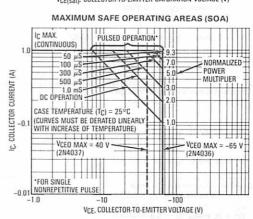












2N4208 2N4209

JAN TX, TXV AVAILABLE CASE 22-03, STYLE 1 TO-18 (TO-206AA)

SWITCHING TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| MAXIMUM KATINGS | | | | |
|---|----------------------|------------------------|--------|----------------|
| Rating | Symbol | 2N4208 | 2N4209 | Unit |
| Collector-Emitter Voltage | VCEO | 12 | 15 | Vdc |
| Collector-Base Voltage | VCBO | 12 | 15 | Vdc |
| Emitter-Base Voltage | VEBO | 4.5 | | Vdc |
| Collector Current — Continuous | lc | 50-200 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.30-0.36 1.72-2.06 | | Watt mW/℃ |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 0.70-1.2 4.0-6.9 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | | °C |

Refer to MM4257 for graphs.

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|--------------------------------------|----------------------|--------------|--------------------|------------------------|--------------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 3.0 mAdc, IB = 0) | 2N4208 2N4209 | V _{(BR)CEO} | 12 15 | 1 1 | | Vdc |
| Collector-Emitter Breakdown Voltage (I _C = 100 μAdc, V _{BE} = 0) | 2N4208 2N4209 | V(BR)CES | 12 15 | 1 1 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μAdc, IE = 0) | 2N4208 2N4209 | V(BR)CBO | 12 15 | | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | _ | V(BR)EBO | 4.5 | 5.9 | 1 | Vdc |
| Collector Cutoff Current (V _{CE} = 6.0 Vdc, V _{BE} = 0) (V _{CE} = 8.0 Vdc, V _{BE} = 0) (V _{CE} = 6.0 Vdc, V _{BE} = 0, T _A = 125°C) (V _{CE} = 8.0 Vdc, V _{BE} = 0, T _A = 125°C) | 2N4208 2N4209 2N4208 2N4209 | ICES | 111 | 111 | 10 10 5.0 5.0 | nAdc μAdc |
| VCE = 8.0 Vdc, VBE = 0, IA = 123 6) Base Current (VCE = 6.0 Vdc, VBE = 0) (VCE = 8.0 Vdc, VBE = 0) | 2N4208 2N4209 | l _B | = | - | 1.0 1.0 | nAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 0.5 Vdc) | 2N4208 2N4209 | hFE | 15 35 | _ | - | _ |
| (I _C = 10 mAdc, V _{CE} = 0.3 Vdc) | 2N4208 2N4209 | | 30 50 | <u>-</u> | 120 120 | |
| $(I_C = 10 \text{ mAdc}, V_{CE} = 0.3 \text{ Vdc}, T_A = -55^{\circ}C)$ | 2N4208 2N4209 | | 12 20 | _ | _ | |
| (I _C = 50 mAdc, V _{CE} = 1.0 Vdc)(1) | 2N4208 2N4209 | | 30 40 | = | = | |
| Collector-Emitter Saturation Voltage (I _C = 1.0 mAdc, I _B = 0.1 mAdc) | 2N4208 2N4209 | VCE(sat) | _ | _ | 0.13 0.15 | Vdc |
| (I _C = 10 mAdc, I _B = 1.0 mAdc) | 2N4208 2N4209 | | = | = | 0.15 0.18 | |
| (I _C = 50 mAdc, I _B = 5.0 mAdc)(1) | 2N4208 2N4209 | | = | _ | 0.5 0.6 | |
| Base-Emitter Saturation Voltage (IC = 1.0 mAdc, IB = 0.1 mAdc) (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc)(1) | | VBE(sat) | 0.75 | 0.7 0.86 1.1 | 0.8 0.90 1.5 | Vdc |

2N4208, 2N4209

| | Characteristic | Ì | Symbol | Min | Тур | Max | Unit |
|--|--|------------------|------------------|------------|--------------|----------|------|
| SMALL-SIGNAL CHA | ARACTERISTICS | | | | | | |
| Current-Gain — Band (IC = 10 mAdc, Vo | dwidth Product E = 10 Vdc, f = 100 MHz) | 2N4208 2N4209 | fT | 700 850 | 1000 1100 | _ | MHz |
| Output Capacitance (VCB = 5.0 Vdc, Ig | = 0, f = 140 kHz) | | C _{obo} | _ | 2.0 | 3.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, Ic | ; = 0, f = 140 kHz) | | C _{ibo} | _ | 2.0 | 3.5 | pF |
| SWITCHING CHARA | CTERISTICS | | | | | | |
| Turn-On Time | | | ton | _ | 10 | 15 | ns |
| Delay Time | (VCC = 1.5 Vdc, VBE = 0, IC = 10 mAdc, IB1 = 1.0 mAdc) | | đ | _ | 5.0 | 10 | ns |
| Rise Time | IC = 10 IIIAGC, 181 = 1.0 IIIAGC, | | t _r | - | 5.0 | 15 | ns |
| Turn-Off Time | (V _{CC} = 1.5 Vdc, | 2N4208 2N4209 | ^t off | = | 12 16 | 15 20 | ns |
| Storage Time | I _C = 10 mAdc, I _{B1} = I _{B2} = 1.0 mAdc) | 2N4208 2N4209 | t _s | = | 12 17 | 15 20 | ns |
| Fall Time | | 2N4208 2N4209 | tf | _ | 6.0 8.0 | 10 10 | ns |
| Storage Time (IC ~ 10 mAdc, IB | 1 ~ 10 mAdc, I _{B2} ~ 10 mAdc) | 2N4208 2N4209 | tg | _ | _ | 15 20 | ns |

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%. (2) fT is defined as the frequency at which |hfe| extrapolates to unity.

2N4234 2N4235 2N4236

CASE 079-02, STYLE 1 TO-39 (TO-205AD)

POWER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| WANTED TO THE O | | • | | | | | | |
|--|----------------------|-------------|--------|----------------|------|-----|-----|-----|
| Rating | Symbol | 2N4234 | 2N4235 | 2N4236 | Unit | | | |
| Collector-Emitter Voltage | VCEO | 40 | 60 | 80 | Vdc | | | |
| Collector-Base Voltage | VCBO | 40 | 60 | 80 | Vdc | | | |
| Emitter-Base Voltage | VEBO | 7.0 | | 7.0 | | | Vdc | |
| Base Current | IB | 0.2 | | 0.2 | | 0.2 | | Vdc |
| Collector Current — Continuous | lc | 1.0 3.0* | | | | | Adc | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.7 | | Watt mW/°C | | | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 6.0 34 | | Watts mW/°C | | | | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | | °C | | | | |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|--------------------------------------|--------|-----|------|
| Thermal Resistance, Junction to Case | Rejc | 29 | °C/W |

| Characteristic | | Symbol | Min | Max | Unit |
|--|--|----------------------|---|---------------------------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Sustaining Voltage(1) (IC = 100 mAdc, IB = 0) | 2N4234 2N4235 2N4236 | VCEO(sus) | 40 60 80 | = | Vdc |
| Collector Cutoff Current (VCE = 30 Vdc, IB = 0) (VCE = 40 Vdc, IB = 0) (VCE = 60 Vdc, IB = 0) | 2N4234 2N4235 2N4236 | ICEO | <u>-</u> - | 1.0 1.0 1.0 | mAdc |
| Collector Cutoff Current (VCE = 40 Vdc, VBE = 1.5 Vdc) (VCE = 60 Vdc, VBE = 1.5 Vdc) (VCE = 80 Vdc, VBE = 1.5 Vdc) (VCE = 30 Vdc, VBE = 1.5 Vdc, TC = 150°C) (VCE = 40 Vdc, VBE = 1.5 Vdc, TC = 150°C) (VCE = 60 Vdc, VBE = 1.5 Vdc, TC = 150°C) | 2N4234 2N4235 2N4236 2N4234 2N4235 2N4236 | ICEX | = | 0.1 0.1 0.1 1.0 1.0 | mAdc |
| Collector Cutoff Current (VCB = 40 Vdc, IE = 0) (VCB = 60 Vdc, IE = 0) (VCB = 80 Vdc, IE = 0) | 2N4234 2N4235 2N4236 | ІСВО | = | 0.1 0.1 0.1 | mAdc |
| Emitter Cutoff Current (VBE = 7 Vdc, IC = 0) | | IEBO | - | 0.5 | mAdc |
| ON CHARACTERISTICS | | | | · · · · · · · · · · · · · · · · · · · | |
| DC Current Gain(1) (I _C = 100 mAdc, V _{CE} = 1.0 Vdc) (I _C = 250 mAdc, V _{CE} = 1.0 Vdc) (I _C = 500 mAdc, V _{CE} = 1.0 Vdc) (I _C = 1.0 Adc, V _{CE} = 1.0 Vdc) | | p4E | 40 30 20 10 | - 150 - - | _ |
| Collector-Emitter Saturation Voltage(1) (IC = 1.0 Adc, Ig = 125 mAdc) | | VCE(sat) | _ | 0.6 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 1.0 Adc, IB = 100 mAdc) | | V _{BE(sat)} | _ | 1.5 | Vdc |
| Base-Emitter On Voltage (IC = 250 mAdc, VCE = 1.0 Vdc) | | V _{BE} | _ | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 100 mAdc, VCE = 10 Vdc, f = 1.0 MHz) | | fτ | 3.0 | _ | MHz |

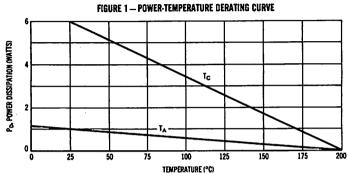
2N4234, 2N4235, 2N4236

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

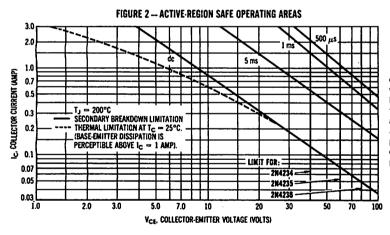
| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|-----|-----|------|
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | C _{obo} | _ | 100 | pF |
| Small-Signal Current Gain (IC = 50 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{fe} | 25 | _ | _ |

⁽¹⁾ Pulse Test: PW ≤ 300 µs, Duty Cycle ≤ 2.0%.

^{*}Indicates Data in addition to JEDEC Requirements.

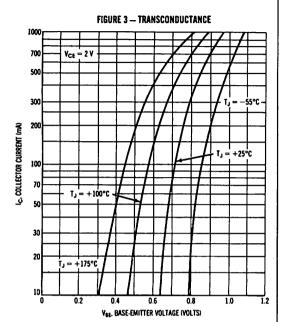


Safe Area Curves are indicated by Figure 2.
All limits are applicable and must be observed.

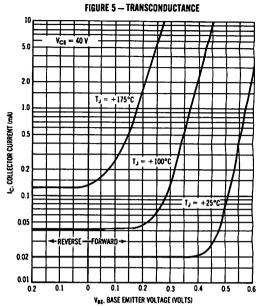


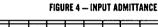
The Safe Operating Area Curves indicate Ic — Vce limits below which the device will not enter secondary breakdown. Collector load lines for specific circuits must fall within the applicable Safe Area to avoid causing a catastrophic failure. To insure operation below the maximum T_J, power-temperature derating must be observed for both steady state and pulse power conditions.

LARGE SIGNAL CHARACTERISTICS



"OFF" REGION CHARACTERISTICS





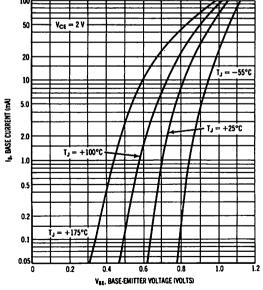
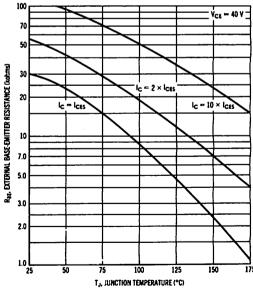
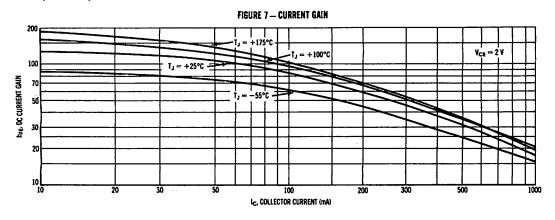
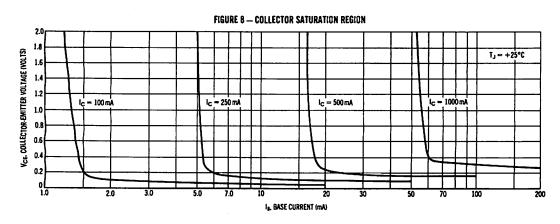


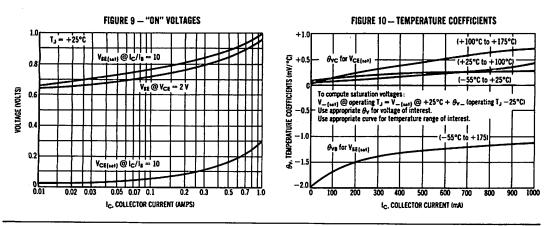
FIGURE 6 — EFFECTS OF BASE-EMITTER RESISTANCE



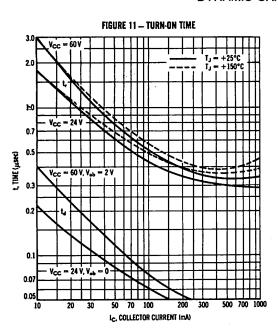


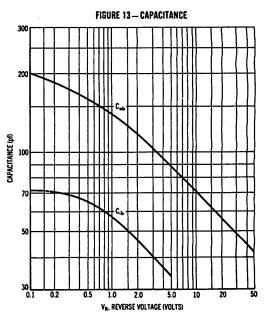
SATURATION REGION CHARACTERISTICS

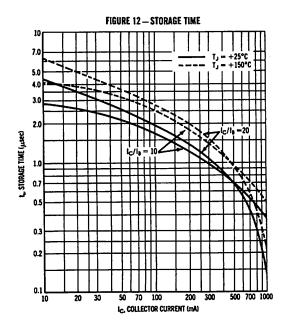


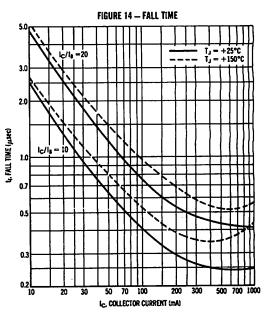


DYNAMIC CHARACTERISTICS









MAXIMUM RATINGS

| WAXIMUM RATINGS | | | | | | | |
|--|------------------|-------------|--------|----------------|---------------|--|-----|
| Rating | Symbol | 2N4237 | 2N4238 | 2N4239 | Unit | | |
| Collector-Emitter Voltage | VCEO | 40 | 60 | 80 | Vdc | | |
| Collector-Base Voltage | V _{CBO} | 50 | 80 | 100 | Vdc | | |
| Emitter-Base Voltage | VEBO | | 6.0 | | Vdc | | |
| Base Current | I _B | 500 | | | 500 | | Vdc |
| Collector Current — Continuous | lc | 1.0 3.0* | | | Adc | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.3 | | | Watt mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 6.0 34 | | Watts mW/°C | | | |
| Operating and Storage Junction Temperature Range | TJ, Tstg | -65 to +200 | | | ొ | | |

2N4237 2N4238 2N4239

CASE 079-02, STYLE 1 TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

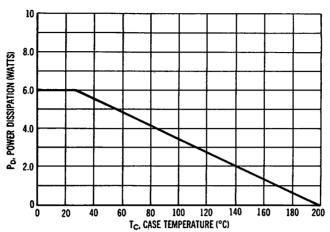
THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---------------------------------------|------------------|-----|------|
| *Thermal Resistance, Junction to Case | R _{ØJC} | 29 | °C/W |

| Characteristic | | Min | Max | Unit |
|--|--|--|---|------------------------------------|
| | | | | |
| 2N4237 2N4238 2N4239 | VCEO(sus) | 40 60 80 | = | Vdc |
| 2N4237 2N4238 2N4239 2N4237 2N4238 2N4239 | ICEX | = = = | 0.1 0.1 0.1 1.0 | mAdc |
| 2114233 | СВО | <u> </u> | 0.1 .07 | mAdc |
| | lEBO | _ | 0.5 | mAdc |
| | | | | |
| | hFE | 30 30 30 15 | 150 | _ |
| | VCE(sat) | _ | 0.3 0.6 | Vdc |
| | V _{BE(sat)} | _ | 1.5 | Vdc |
| | V _{BE(on)} | _ | 1.0 | Vdc |
| | | | | • |
| -,- | C _{obo} | | 100 | pF |
| • | hfe | 30 | | _ |
| | 1 | | | |
| | 2N4238 2N4239 2N4237 2N4238 2N4239 2N4237 | 2N4237 2N4238 2N4239 2N4237 2N4238 2N4239 2N4237 2N4238 2N4239 ICBO IEBO VCE(sat) VBE(sat) VBE(on) | 2N4237 2N4238 2N4239 2N4237 2N4238 2N4239 2N4239 2N4239 2N4239 | 2N4237 2N4238 2N4239 2N4239 CEX |

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle 2.0%. *Indicates Data in addition to JEDEC Requirements.

FIGURE 1 — POWER-TEMPERATURE DERATING CURVE



Safe Area Curves are indicated by Figure 5. All limits are applicable and must be observed.

SWITCHING CHARACTERISTICS

FIGURE 2 - SWITCHING TIME EQUIVALENT CIRCUIT

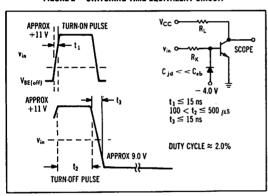


FIGURE 3 — TURN-ON TIME

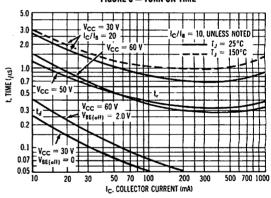
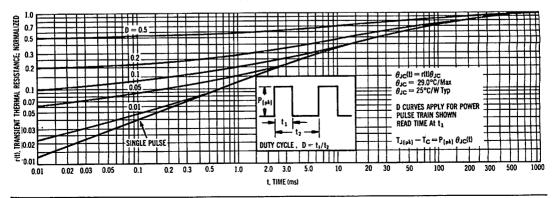
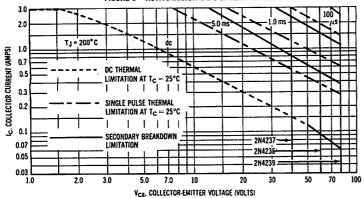


FIGURE 4 — THERMAL RESPONSE

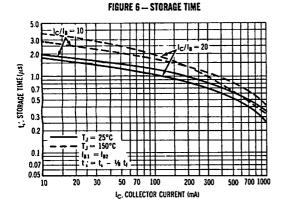


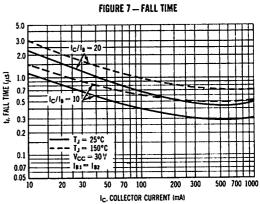




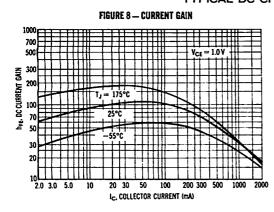
There are two limitations on the power handling ability of a transistor: junction temperature and secondary breakdown. Safe operating area curves indicate I_C—V_{CE} limits of the transistor that must be observed for reliable operation; i.e., the transistor must not be subjected to greater dissipation than the curves indicate.

For this particular transistor family, the thermal curves are the limiting design values, except for a small portion of the dc curve. The pulse secondary breakdown curves are shown for information only.





TYPICAL DC CHARACTERISTICS



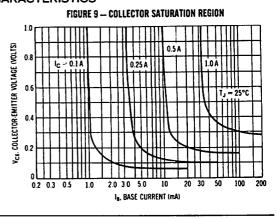
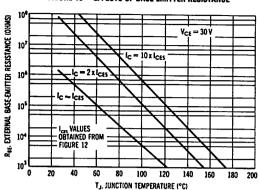


FIGURE 10 — EFFECTS OF BASE-EMITTER RESISTANCE



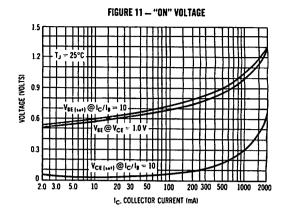


FIGURE 12 — COLLECTOR CUTOFF REGION

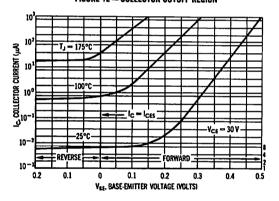
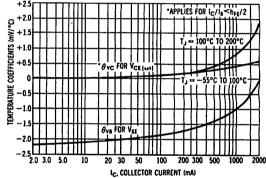


FIGURE 13 - TEMPERATURE COEFFICIENTS



2N4260 2N4261

2N4261 JAN, JTX AVAILABLE CASE 20, STYLE 10 TO-72

SWITCHING TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Madeline in 19111100 | | | | | | | | |
|--|----------------------|-------------|-------------|--|--|--|--|--|
| Rating | Symbol | Value | Unit | | | | | |
| Collector-Emitter Voltage | VCEO | 15 | Vdc | | | | | |
| Collector-Base Voltage | VCBO | 15 | Vdc | | | | | |
| Emitter-Base Voltage | VEBO | 4.5 | Vdc | | | | | |
| Collector Current — Continuous | IC | 30 | mAdc | | | | | |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 200 1.14 | mW mW/°C | | | | | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | °C | | | | | |

| Characteristic | | Symbol | Min | Max | Unit |
|---|------------------|------------------|----------------|----------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 10 mAdc, IE = 0) | | V(BR)CEO | 15 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | | V(BR)CBO | 15 | | Vdc |
| (I _E = 10 μAdc, I _C = 0) | | V(BR)EBO | 4.5 | _ | Vdc |
| Collector Cutoff Current (VCE = 10 Vdc, VBE(off) = 2.0 Vdc) (VCE = 10 Vdc, VBE(off) = 2.0 Vdc, TA = 150°C) (VCE = 10 Vdc, VEB(on) = 0.4 Vdc) | | ICEX | _ | 0.005 5.0 0.05 | μAdc |
| Base Cutoff Current (VCE = 10 Vdc, VBE(off) = 2.0 Vdc) | | ^I BL | _ | 0.005 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 1.0 mAdc, VCE = 1.0 Vdc) (IC = 10 mAdc, VCE = 1.0 Vdc) (IC = 30 mAdc, VCE = 2.0 Vdc) | | pŁE | 25 30 20 | 150 | - |
| Collector-Emitter Saturation Voltage (I _C = 1.0 mAdc, I _B = 0.1 mAdc) (I _C = 10 mAdc, I _B = 1.0 mAdc) | | VCE(sat) | = | 0.15 0.35 | Vdc |
| Base-Emitter On Voltage (IC = 1.0 mAdc, VCE = 1.0 Vdc) (IC = 10 mAdc, VCE = 1.0 Vdc) | | VBE(on) | _ | 0.8 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (I _C = 5.0 mAdc, V _{CE} = 4.0 Vdc, f = 100 MHz) | 2N4260 2N4261 | fT | 1200 1500 | = | MHz |
| (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | 2N4260 2N4261 | | 1600 2000 | _ | |
| Output Capacitance (VCB = 4.0 Vdc, IE = 0, f = 100 kHz) | | C _{obo} | | 2.5 | pF |
| Input Capacitance (V _{BE} = 0.5 Vdc, I _C = 0, f = 100 kHz) | | C _{ibo} | _ | 2.5 | pF |
| Current Gain — High Frequency (IC = 10 mAdc, VCE = 10 Vdc, f = 100 MHz) | 2N4260 2N4261 | lhfel | 16 20 | = | _ |

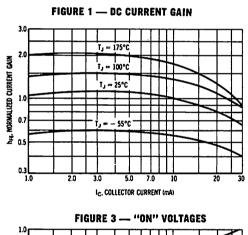
2N4260, 2N4261

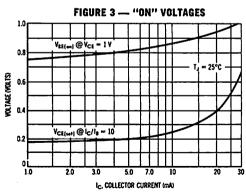
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

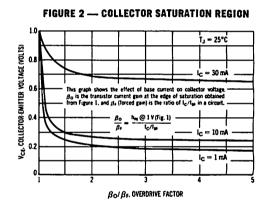
| Characteristic | | Symbol | Min | Max | Unit |
|---|------------------|-------------------|-----|----------|------|
| Collector Base Time Constant (IC = 5.0 mAdc, VCE = 4.0 Vdc, f = 31.8 MHz) | 2N4260 2N4261 | rb'C _C | _ | 35 60 | ps |
| (IC = 10 mAdc, VCE = 10 Vdc, f = 31.8 MHz) | 2N4260 2N4261 | | _ | 30 50 | |

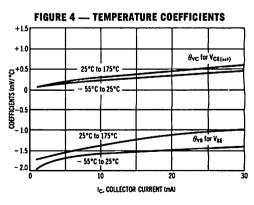
Typical Performance (v_{out} = 1.0 V)

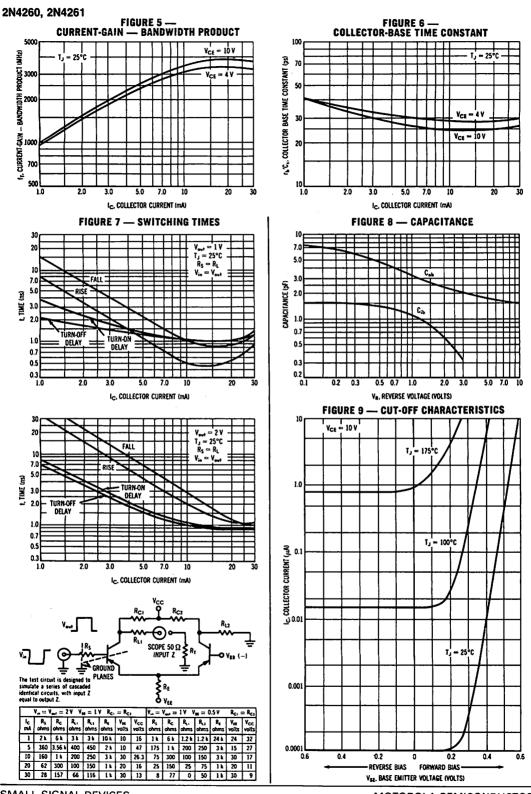
| SWITCHING CHARACTERISTICS | | @ 10 mA | @ 30 mA | |
|---------------------------|-------------|---------|---------|----|
| Rise Time | tr | 0.5 | 0.9 | ns |
| Fall Time | tf | 1.0 | 1.2 | ns |
| Turn-On Time | ton(delay) | 1.0 | 1.2 | ns |
| Turn-Off Delay Time | toff(delay) | 1.0 | 1.2 | ns |











2N4404 2N4405

CASE 79, STYLE 1 TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|--------------|----------------|
| Collector-Emitter Voltage | VCEO | 80 | Vdc |
| Collector-Base Voltage | VCBO | 80 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 1.0 | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.25 7.15 | Watts mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 8.75 50 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|-----|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 25 | °C/W |
| Thermal Resistance, Junction to Ambient | Raja | 140 | °C∕W |

| Characteristic | | Symbol | Min | fin Max Unit | |
|---|------------------|---------------------|-----------|--------------------|----------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 m/ | Adc, Ig = 0) | V(BR)CEO | 80 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, I | E = 0) | V(BR)CBO | 80 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C | = 0) | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 60 Vdc, IE = 0) | | СВО | _ | 25 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | | ^I EBO | _ | 25 | nAdc |
| ON CHARACTERISTICS | | | | | • |
| DC Current Gain (I _C = 0.1 mAdc, V _{CE} = 5.0 Vdc) | 2N4404 2N4405 | hFE | 30 75 | _ | - |
| (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) | 2N4404 2N4405 | | 40 100 | = | 1 |
| (I _C = 150 mAdc, V _{CE} = 5.0 Vdc)(1) | 2N4404 2N4405 | | 40 100 | 120 300 | <u> </u> |
| (I _C = 500 mAdc, V _{CE} = 5.0 Vdc)(1) | 2N4404 2N4405 | | 30 50 | = | |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 150 mAdc, I _B = 15 mAdc)(1) (I _C = 500 mAdc, I _B = 50 mAdc)(1) | | VCE(sat) | = | 0.15 0.2 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 500 mAdc, IB = 50 mAdc)(1) | | VBE(sat) | 0.85 | 0.8 1.2 | Vdc |
| Base-Emitter On Voltage (IC = 150 mAdc, VCE = 1.0 Vdc) | | V _{BE(on)} | _ | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 20 Vdc, f = 100 MHz) | | fτ | 200 | 600 | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | | C _{cb} | _ | 10 | pF |
| Emitter-Base Capacitance (VBE = 0.5 Vdc, IC = 0, f = 1.0 MHz) | | Cép | _ | 75 | pF |

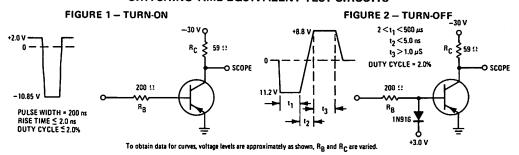
2N4404, 2N4405

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| | Characteristic | | Min | Max | Unit |
|------------------|--|----------------|-----|-----|------|
| SWITCHING CHARAC | CTERISTICS | | | | |
| Delay Time | (V _{CC} = 30 Vdc, V _{BE(off)} = 2.0 Vdc, | t _d | | 15 | ns |
| Rise Time | IC = 500 mAdc, IB1 = 50 mAdc) | tr | _ | 25 | ns |
| Storage Time | (V _{CC} = 30 Vdc, l _C = 500 mAdc, | ts | _ | 175 | ns |
| Fail Time | I _{B1} = I _{B2} = 50 mAdc) | tę | _ | 35 | ns |

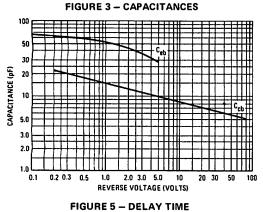
⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

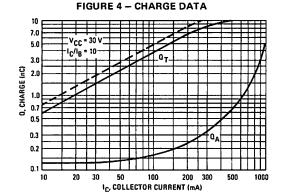
SWITCHING TIME EQUIVALENT TEST CIRCUITS

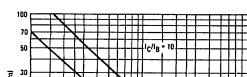


TRANSIENT CHARACTERISTICS









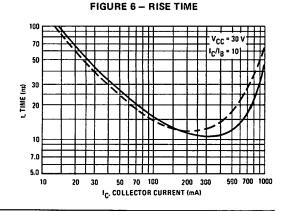
50 70 100

IC. COLLECTOR CURRENT (mA)

VBE(off) = 0 V

V_{BE(off)} = 2.0 V

200 300



20

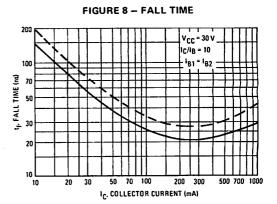
20

10

5.0

500 700 1000

FIGURE 7 - STORAGE TIME 1000 l_{B1} ¹B2 700 500 V_{CC} = 30 V 300 ts. STORAGE TIME (ns) 200 100 · 1/3 t 50 30 20 10 500 700 1000 10 20 30 70 100 200 300 IC. COLLECTOR CURRENT (mA)

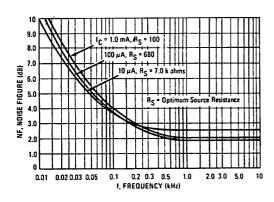


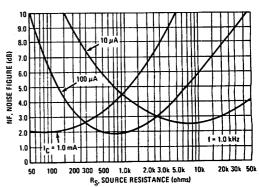
SMALL-SIGNAL CHARACTERISTICS

NOISE FIGURE V_{CF} = 10 Vdc, T_A = 25°C

FIGURE 9 - FREQUENCY EFFECTS

FIGURE 10 - SOURCE RESISTANCE EFFECTS



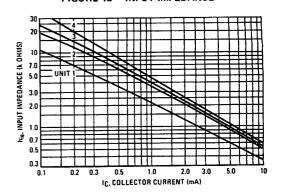


h PARAMETERS V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C

This group of graphs illustrates the relationship of the "h" parameters for this series of transistors. To obtain these curves, 4 units were selected and identified by number - the same units were used to develop curves on each graph. FIGURE 12 - INPUT IMPEDANCE



300 200 Me. CURRENT GAIN 100 30 20 16 10 0.5 1.0 2.0 0.1 0.2 0.3 IC, COLLECTOR CURRENT (mA)



SMALL-SIGNAL DEVICES

2N4404, 2N4405

FIGURE 13 - VOLTAGE FEEDBACK RATIO

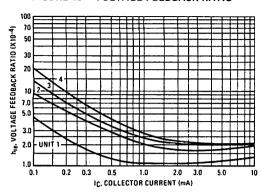
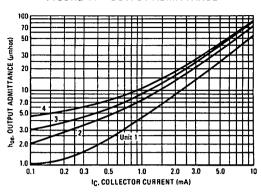


FIGURE 14 - OUTPUT ADMITTANCE



STATIC CHARACTERISTICS

FIGURE 15 - DC CURRENT GAIN

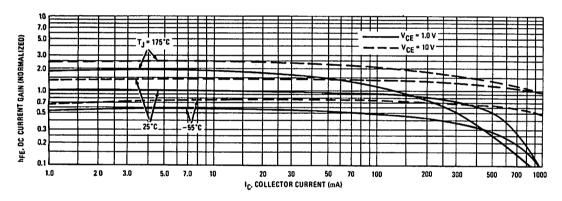
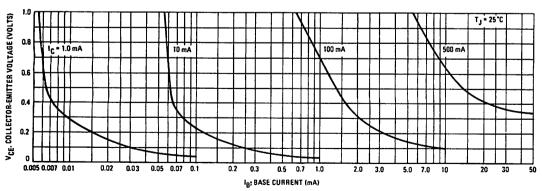
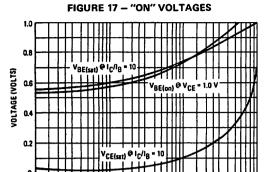


FIGURE 16 - COLLECTOR SATURATION REGION



2.0 3.0 5.0

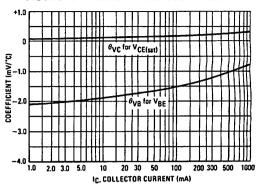
10



20 30 50 100

IC COLLECTOR CURRENT (mA)

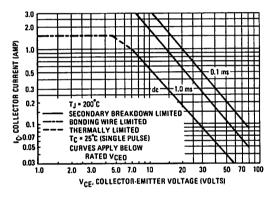
FIGURE 18 - TEMPERATURE COEFFICIENTS



RATINGS AND THERMAL DATA

200 300 500 1000

FIGURE 19 - SAFE OPERATING AREA



The safe operating area curves indicate $1_{\rm C}{}^{\rm LV}{}_{\rm CE}$ limits of the transistor that must be observed for raibable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve. The data of Figure 19 is based upon $T_{\rm J(pk)}$ =

200°C; T_C is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J[pk)} \leq 200$ °C. $T_{J[pk)}$ may be calculated from the data in Figure 20. At high case temperatures, thermal limitations will reduce the power that can be handled to values test than the limitations imposed by second breakdown.

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|----------|--------------|----------------|
| Collector-Emitter Voltage | VCEO | 80 | Vdc |
| Collector-Base Voltage | VCBO | 80 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| *Collector Current — Continuous* | lc | 2.0 | Amps |
| Total Device Dissipation @ T _A = 25°C* Derate above 25°C | PD | 1.25 7.15 | Watts mW/°C |
| Total Device Dissipation @ T _C = 25°C* Derate above 25°C | PD | 8.75 50 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, Tstg | -65 to +200 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|-------------------|-----|------|
| Thermal Resistance, Junction to Case | R _Ø JC | 20 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 140 | °C/W |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

2N4406 2N4407

CASE 79, STYLE 1 TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|-----|-----|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | V(BR)CEO | 80 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 80 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | V(BR)EBO | 5.0 | | Vdc |
| Collector Cutoff Current (V _{CB} = 60 Vdc, I _E = 0) | ICBO | | 25 | μAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | l _{EBO} | _ | 25 | μAdc |

| ON | CHA | RΔ | CTER | ISTICS |
|----|-----|----|------|--------|

| DC Current Gain(1) | | hFE. | | | |
|---|----------------|----------------------|-----|-----|-----|
| (IC = 10 mAdc, VCE = 5.0 Vdc) | 2N4406 | | 30 | _ | i |
| } | 2N4407 | | 80 | | |
| (IC = 150 mAdc, VCE = 5.0 Vdc) | 2N4406 | | 30 | _ | ļ |
| | 2N4407 | | 80 | _ | |
| (IC = 500 mAdc, VCE = 5.0 Vdc) | 2N4406 | | 30 | 120 | |
| | 2N4407 | | 80 | 240 | |
| (IC = 1.0 Adc, VCE = 5.0 Vdc) | 2N4406 | | 20 | _ | |
| | 2N4407 | | 30 | _ | |
| (IC = 1.5 Adc, VCE = 5.0 Vdc) | 2N4406, 2N4407 | <u> </u> | 10 | _ | |
| Collector-Emitter Saturation Voltage | | V _{CE(sat)} | | | Vdc |
| (IC = 150 mAdc, IB = 15 mAdc) | | | – | 0.2 | |
| (IC = 500 mAdc, IB = 50 mAdc) | | 1 | _ | 0.4 | |
| (Ic = 1.0 Adc, IB = 100 mAdc) | | | _ | 0.7 | |
| (I _C = 1.5 Adc, I _B = 150 mAdc) | | | | 1.5 | |
| Base-Emitter Saturation Voltage | | V _{BE(sat)} | | | Vdc |
| (Ic = 150 mAdc, Ig = 15 mAdc) | | | | 0.9 | |
| (Ic = 1.0 Adc, Ig = 100 mAdc) | | 1 | 0.9 | 1.3 | |
| (I _C = 1.5 Adc, I _B = 150 mAdc) | | ļ | | 1.5 | |
| Base-Emitter On Voltage | | VBE(on) | - | 1.0 | Vdc |
| (IC = 500 mAdc, VCE = 1.0 Vdc) | | <u> </u> | | | |

SMALL-SIGNAL CHARACTERISTICS

| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 20 Vdc, f = 100 MHz) | fτ | 150 | 750 | MHz |
|---|-----------------|-----|-----|-----|
| Collector-Base Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | C _{cb} | _ | 15 | pF |
| Emitter-Base Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | C _{eb} | _ | 160 | pF |

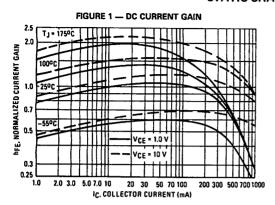
2N4406, 2N4407

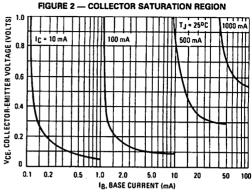
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

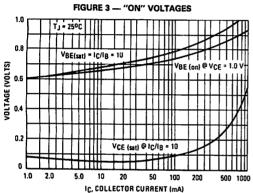
| | Characteristic | Symbol | Min | Max | Unit |
|------------------|--|--------|-----|-----|------|
| SWITCHING CHARAC | TERISTICS | | | | |
| Delay Time | (VCC = 30 Vdc, VBE(off) = 2.0 Vdc, | td | _ | 15 | ns |
| Rise Time | IC = 1.0 Adc, IB1 = 100 mAdc) | tr | - | 60 | ns |
| Storage Time | (V _{CC} = 30 Vdc, I _C = 1.0 Adc, | ts | _ | 175 | ns |
| Fall Time | I _{B1} = I _{B2} = 100 mAdc) | tf | _ | 50 | ns |

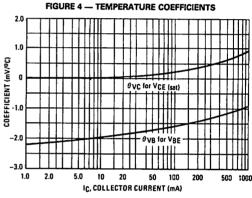
⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%. *Indicates Data in addition to JEDEC Requirements.

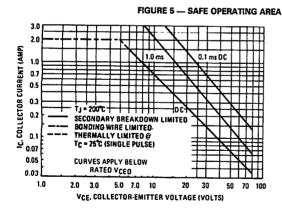
STATIC CHARACTERISTICS











The safe operating area curves indicate IC-VCE limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 5 is based upon $T_{J(pk)} = 200^{\circ}C$; T_C is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \le 200^{\circ}C$. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

TRANSIENT CHARACTERISTICS ----- 25°C --- 100°C

FIGURE 7 - CAPACITANCES

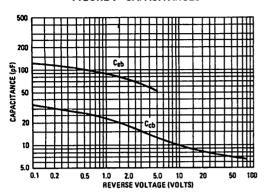


FIGURE 8 - CHARGE DATA

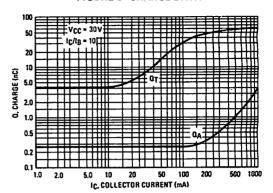


FIGURE 9 - TURN-ON TIME

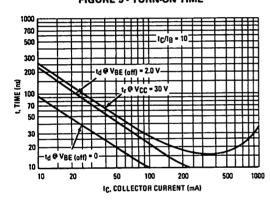
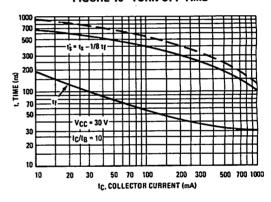


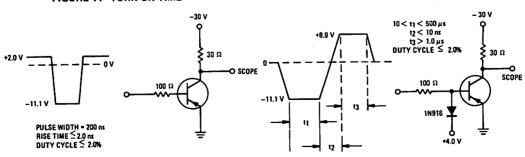
FIGURE 10 - TURN-OFF TIME



SWITCHING TIME EQUIVALENT TEST CIRCUITS

FIGURE 11 - TURN-ON TIME

FIGURE 12 - TURN-OFF TIME



2N4453

For Specifications, See 2N869A Data.

MAXIMUM RATINGS

| modification to the control of the c | | | |
|--|-----------------------------------|-------------|---------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lc | 1.0 | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.7 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | Watts mW/℃ |
| Operating and Storage Junction | T _J , T _{stg} | -65 to +200 | °C |

2N4890

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

Refer to 2N4033 for graphs.

| | TOTEL HOTTOO (TA - 25 C GINESS OTHERWISE HOTEU.) | | | | | |
|---|--|----------------------|----------------|---------------------------------------|------|------|
| | Characteristic | Symbol | Min | Тур | Max | Unit |
| OFF CHARACTERISTICS | s | • | | <u> </u> | | |
| Collector-Emitter Break | down Voltage(1) (IC = 100 μAdc, IB = 0) | V(BR)CEO | 40 | I – | I – | Vdc |
| Collector-Emitter Break | down Voltage (IC = 10 mAdc, RBE = 10 ohms) | V(BR)CER | 50 | _ | _ | Vdc |
| Collector-Base Breakdor | wn Voltage (I _C = 100 μAdc, I _E = 0) | V(BR)CBO | 60 | _ | _ | Vdc |
| Emitter-Base Breakdow | n Voltage (I _E = 100 μAdc, I _C = 0) | V(BR)EBO | 5.0 | = | - | Vdc |
| Collector Cutoff Current | (V _{CE} = 60 Vdc, V _{BE(off)} = 1.5 Vdc) | ICEX | _ | | 0.25 | μAdc |
| | /CE = 60 Vdc, VBE(off) = 1.5 Vdc) | IBL | _ | | 0.25 | μAdc |
| ON CHARACTERISTICS | | -1 | - | · · · · · · · · · · · · · · · · · · · | | |
| DC Current Gain (IC = 150 mAdc, VC) (IC = 150 mAdc, VC) *(IC = 500 mA, VCE) | E = 10 Vdc) | hFE | 25 50 15 | 130 140 | 250 | - |
| Collector-Emitter Setura | | VCE(sat) | _ | 0.12 | 1.4 | Vdc |
| Base-Emitter Saturation (IC = 150 mAdc, IB = | | V _{BE(sat)} | 1 | 0.82 | 1.7 | Vdc |
| Base-Emitter On Voltage (IC = 150 mAdc, VCE | | VBE(on) | _ | 0.74 | 1.7 | Vdc |
| SMALL-SIGNAL CHARA | ACTERISTICS | | | · | | |
| Current-Gain — Bandwi (IC = 50 mAdc, VCE : | dth Product = 10 Vdc, f = 20 MHz) | fT | 100 | 280 | - | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = | 0, f = 140 kHz) | C _{obo} | - | 9.0 | 15 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = | 0, f = 140 kHz) | Cibo | _ | 60 | 80 | pF |
| SWITCHING CHARACTE | RISTICS | | | | | |
| Delay Time | (V _{CC} = 30 Vdc, V _{BE(off)} = 0.8 Vdc, | td | | 15 | 50 | ns |
| Rise Time | IC = 150 mAdc, IB1 = 15 mAdc) | tr | 20 | 20 | 50 | ns |
| Storage Time | (V _{CC} = 30 Vdc, I _C = 150 mAdc, | ts | _ | 110 | 200 | ns |
| Fall Time | I _{B1} = I _{B2} = 15 mAdc) | tf | _ | 20 | 70 | ns |
| | | | | | | .10 |

⁽¹⁾ Pulse Test: Pulse Width = 300 µs, Duty Cycle ≤ 2.0%.

^{*}Indicates Data in Addition to JEDEC Requirements.

2N4924 2N4925

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| INVINOISI PATITAGO | | | | |
|---|-----------------------------------|-------------|--------|----------------|
| Rating | Symbol | 2N4924 | 2N4925 | Unit |
| Collector-Emitter Voltage | VCEO | 100 150 | | Vdc |
| Collector-Base Voltage | VCBO | 100 150 | | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc |
| Collector Current — Continuous | lc | 200 | | mAdc |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 1.0 5.71 | | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | °C |

THERMAL CHARACTERISTICS

| *************************************** | | | |
|---|--------|-----|------|
| Characteristic | Symbol | Max | Unit |
| Thermal Resistance, Junction to Case | ReJC | 35 | °CW |
| Thermal Resistance, Junction to Ambient | ReJA | 175 | °C/W |

Refer to 2N3498 for graphs.

| Characteristic | | . Symbol . | Min | Max | Unit |
|--|------------------|----------------------|----------------|--------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (1) (IC = 10 mAdc, Ig = 0) | 2N4924 2N4925 | V(BR)CEO | 100 150 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | 2N4924 2N4925 | V(BR)CBO | 100 150 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IF = 10 µAdc, IC = 0) | | V _{(BR)EBO} | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) (VCB = 75 Vdc, IE = 0) | | ІСВО | <u>-</u> | 0.1 0.1 | μAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc) | | IEBO | _ | 0.1 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc) (IC = 10 mAdc, VCE = 10 Vdc) (IC = 150 mAdc, VCE = 10 Vdc) | | hFE | 25 35 40 | _ _ _ 200 | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc) | | VCE(sat) | | 0.25 0.4 | Vdc |
| Base-Emitter On Voltage (IC = 50 mAdc, VCE = 10 Vdc) | | VBE(on) | | 0.95 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | ., |
| Current-Gain — Bandwidth Product (2) (I _C = 20 mAdc, V _{CE} = 20 Vdc, f = 100 MHz) | | fτ | 100 | 500 | MHz |
| Collector-Base Capacitance (VCB = 20 Vdc, IE = 0, f = 140 kHz) | | C _{cb} | | 10 | pF |
| Emitter-Base Capacitance (VFB = 1.0 Vdc, IC = 0, f = 140 kHz) | | C _{eb} | _ | 80 | ρF |

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%. (2) fT = |hfe| \bullet ftest.

MAXIMUM RATINGS

| *************************************** | | | | |
|---|----------|-------------|--------|----------------|
| Rating | Symbol | 2N4926 | 2N4927 | Unit |
| Collector-Emitter Voltage | VCEO | 200 | 250 | Vdc |
| Collector-Base Voltage | VCBO | 200 | 250 | Vdc |
| Emitter-Base Voltage | VEBO | 7.0 | | Vdc |
| Collector Current — Continuous | ΙC | 50 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.71 | | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | Tj, Tstg | -65 to +200 | | °C |

THERMAL CHARACTERISTICS

| . Characteristic | Symbol | Max | Unit |
|---|------------------|-----|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 35 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 175 | °C/W |

2N4926 2N4927

CASE 79, STYLE 1 TO-39 (TO-205AD) AMPLIFIER TRANSISTOR

NPN SILICON

| ELECTRICAL CHARACTERISTICS (TA | 25°C unless otherwise noted.) |
|--------------------------------|-------------------------------|

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|----------------------|------------------------|--------------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (1) (IC = 10 mAdc, IB = 0) 2N4926 2N4927 | V(BR)CEO | 200 250 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.1 mAdc, IC = 0) 2N4926 2N4927 | V(BR)CBO | 200 250 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 0.1 mAdc, I _C = 0) | V _{(BR)EBO} | 7.0 | | Vdc |
| Collector Cutoff Current (VCB = 100 Vdc, IE = 0) (VCB = 100 Vdc, IE = 0, TA = 100°C) (VCB = 150 Vdc, IE = 0, TA = 100°C) (VCB = 150 Vdc, IE = 0, TA = 100°C) | Ісво | _ _ _ | 0.1 10 0.1 10 | μAdc |
| Emitter Cutoff Current (VBE = 5.0 Vdc) | IEBO | _ | 0.1 | μAdc |
| ON CHARACTERISTICS (1) | | | | 1 |
| DC Current Gain (I _C = 3.0 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc) (I _C = 30 mAdc, V _{CE} = 10 Vdc) (I _C = 50 mAdc, V _{CE} = 20 Vdc) | hFE | 10 15 20 20 | 200 | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 30 mAdc, I _B = 3.0 mAdc) | V _{CE(sat)} | | 1.0 2.0 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 3.0 mAdc) | V _{BE(sat)} | _ | 1.2 1.5 | Vdc |
| Base-Emitter On Voltage (I _C = 30 mAdc, V _{CE} = 10 Vdc) | V _{BE(on)} | _ | 1.5 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 20 MHz) | fŢ | 30 | 300 | MHz |
| Collector-Base Capacitance (VCB = 20 Vdc, IE = 0, f = 140 kHz) | Ccb | _ | 6.0 | pF |
| Input Impedance (IC = 10 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | hie | 75 | 2000 | ohm |
| Voltage Feedback Ratio (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{re} | 0.1 | 2.0 | X 10-4 |
| Small-Signal Current Gain (IC = 10 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | hfe | 25 | 250 | _ |
| Output Admittance (IC = 10 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | hoe | _ | 50 | μmhos |
| Real Part of Input Impedance (IC = 10 mAdc, VCE = 20 Vdc, f = 5.0 MHz) | Re(hie) | 4.0 | 200 | ohms |

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

2N4928 thru 2N4931

2N4930 and 2N4931 JAN, JTX & JTXV AVAILABLE CASE 79, STYLE 1 TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | 2N4928 | 2N4929 | 2N4930 | 2N4931 | 000 |
|--|----------------------|-------------|-------------|-------------|-------------|---------------|
| Collector-Emitter Voltage | VCEO | 100 | 150 | 200 | 250 | Vde |
| Collector-Base Voltage | VCBO | 100 | 150 | 200 | 250 | Vde |
| Emitter-Base Voltage | VEBO | 4.0 | 4.0 | 4.0 | 4.0 | Vdc |
| Collector Current — Continuous | lc | 100 | 500 | 500 | 500 | mAde |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 0.6 3.4 | 1.0 5.71 | 1.0 5.71 | 1.0 5.71 | Watt mW/*C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 3.0 17.2 | 5.0 28.6 | 5.0 28.6 | 5.0 28.6 | Wett mW/*C |
| Operating and Storage Junction Temperature Range | Tj, T _{stg} | -65 to +200 | | | | * |

Refer to 2N3494 for graphs for 2N4928.*

| Characteristic | | Symbol | Min | Max | Units |
|--|--------------------------------------|---------------------|--------------------------|-------------------|-------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (I _C = 10 mAdc, I _B = 0) · | 2N4928 2N4929 2N4930 2N4931 | V(BR)CEO | 100 150 200 250 | - - - | Vdc |
| Collector-Base Breakdown Voltage (I _E = 0, I _C = 100 μAdc) | 2N4928 2N4929 2N4930 2N4931 | V(BR)CBO | 100 150 200 250 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 4.0 | - | Vdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) (VCB = 75 Vdc, IE = 0) (VCB = 150 Vdc, IE = 0) | 2N4928 2N4929 2N4930, 2N4931 | Ісво | = | 0.5 0.5 1.0 | μAdic |
| Emitter Cutoff Current (VBE = 3.0 Vdc, I _C = 0) (VBE = 3.0 Vdc, I _C = 0) | 2N4928, 2N4929 2N4930, 2N4931 | †EBO | | 0.5 1.0 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc) | All Types | hFE | 20 | _ | - |
| (IC = 10 mAdc, VCE = 10 Vdc)(1) | 2N4928, 2N4929 2N4930, 2N4931 | | 25 20 | 200 200 | |
| (I _C = 50 mAdc, V _{CE} = 10 Vdc)(1) (I _C = 30 mAdc, V _{CE} = 10 Vdc)(1) | 2N4928, 2N4929 2N4930, 2N4931 | | 20 20 | = | |
| Collector-Emitter Saturation Voltage(1) (IC = 10 mAdc, IB = 1.0 mAdc) | 2N4928, 2N4929 2N4930, 2N4931 | VCE(sat) | Ξ | 0.5 5.0 | Vde |
| Base-Emitter On Voltage (IC = 10 mAdc, VCE = 10 Vdc) | | V _{BE(on)} | _ | 1.0 | Vdc |

2N4928 thru 2N4931

| Characteristic | | Symbol | Min | Max | Unit |
|---|----------------|-----------------|-----|-------|------|
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product | | fT | | | MHz |
| (IC = 20 mAdc, VCE = 20 Vdc, f = 100 MHz) | 2N4928, 2N4929 | | 100 | 1,000 | |
| (IC = 20 mAdc, VCE = 20 Vdc, f = 20 MHz) | 2N4930, 2N4931 | | 20 | 200 | |
| Collector-Base Capacitance | | C _{cb} | | | рF |
| (VCB = 20 Vdc, lp = 0, f = 140 kHz) | 2N4928 | | _ | 6.0 | |
| (VCB = 20 Vdc, Ip = 0, f = 140 kHz) | 2N4929 | | _ | 10 | İ |
| (VCB = 20 Vdc, IE = 0, f = 140 kHz) | 2N4930, 2N4931 | | | 20 | |
| Emitter-Base Capacitance | | Ceb | | | pF |
| (VBE = 2.0 Vdc, IC = 0, f = 140 kHz) | 2N4928 | 1 1 | _ | 40 | 1 |
| (VBE = 1.0 Vdc, IC = 0, f = 140 kHz) | 2N4929 | 1 | _ | 80 | ł |
| (VBE = 0.5 Vdc, IC = 0, f = 140 kHz) | 2N4930, 2N4931 | 1 | _ | 400 | |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%. Refer to 2N3634 for graphs for 2N4929. Refer to 2N3743 for graphs for 2N4930 and 2N4931.

2N5022 2N5023

CASE 079-02, STYLE 1 TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| THE PRINCIPAL IN COLUMN 1997 | | | | |
|---|-----------------------------------|-------------|--------|----------------|
| Rating | Symbol | 2N5022 | 2N5023 | Unit |
| Collector-Emitter Voltage | VCEO | 50 | 30 | ٧ |
| Collector-Emitter Voltage | VCES | 50 | 30 | V |
| Collector-Base Voltage | V _{CBO} | 50 | 30 | ٧ |
| Emitter-Base Voltage | VEBO | 5 | | ٧ |
| Collector Current — Continuous (Pulse Width = 300 \(mus, DC = 1\%) | lc | 1.0* | | Α |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.72 | | Watts mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 4.0 22.8 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | °C |
| Maximum Lead Temperature (Soldering, 60 sec max) | TL | +300 | | ů |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|-----------------|------|------|
| Thermal Resistance, Junction to Case | RøJC | 43.8 | °C/W |
| Thermal Resistance, Junction to Ambient | $R_{\theta JA}$ | 175 | °C/W |

Refer to 2N3467 for graphs. *Indicates Data in Addition to JEDEC Requirements.

italia to altovor for graphic.

| Characteristic | | Symbol | Min | Max | Unit |
|--|----------------------------|----------------|----------------|-----------------|----------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 100 µAdc) | 2N5022 2N5023 | V(BR)CES | 50 30 | = | ٧ |
| Collector-Emitter Sustaining Voltage (IC = 10 mAdc) | 2N5022 2N5023 | V(BR)CEO(sus)* | 50 30 | = | ٧ |
| Collector-Base Breakdown Voltage (IC = 100 μAdc) | 2N5022 2N5023 | V(BR)CBO | 50 30 | = | ٧ |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc) | All | V(BR)EBO | 5.0 | - | ٧ |
| Collector Cutoff Current (VCE = 30 Vdc) (VCE = 20 Vdc) (TA = 100°Cdc) | 2N5022 2N5023 | ICES | = | 100 15 | nA μA |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(1) (IC = 100 mA, V _{CE} = 1.0 Vdc) (IC = 500 mA, V _{CE} = 1.0 Vdc) | 2N5022 2N5023 2N5022 | hFE | 15 30 25 | 100 | _ |
| (IC = 500 (IIA, VCE = 1.0 vdc) | 2N5023 | | 40 | 100 | |
| $(I_C = 1.0 \text{ A, V}_{CE} = 5.0 \text{ Vdc})$ | 2N5022 2N5023 | | 25 40 | = | |
| $(I_C = 500 \text{ ma, V}_{CE} = 1.0 \text{ V, T}_A = -55^{\circ}\text{C})$ | 2N5022 2N5023 | | 10 20 | = | |
| Collector-Emitter Saturation Voltage(1) (I _C = 100 mAdc, I _B = 10 mAdc) | 2N5022 2N5023 | VCE(sat) | _ | 0.20 0.17 | v |
| (IC = 500 mAdc, IB = 50 mAdc) | 2N5022 2N5023 | | Ξ | 0.40 0.35 | v |
| (IC = 1.0 Adc, IB = 100 mAdc) | 2N5022 2N5023 | | _ | 0.80 0.70 | l I v |

2N5022, 2N5023

| Characteristic | Symbol | Min | Max | Unit |
|---|----------------------|------------|----------|------|
| Base-Emitter Saturation Voltage | V _{BE(sat)} | | | |
| (IC = 100 mAdc, Ig = 10 mAdc) (IC = 500 mAdc, Ig = 50 mAdc) | | - | 1.0 | V |
| (IC = 1.0 Adc, Ig = 100 mAdc) | | 0.8 | 1.4 | V |
| SMALL-SIGNAL CHARACTERISTICS | | | | L |
| Collector-Base Capacitance (VBE = 0.5 V, f = 100 kHz) | C _{cb} | _ | 25 | pF |
| Emitter-Base Capacitance (VBE = 0.5 V, f = 100 kHz) | C _{eb} | _ | 100 | ρF |
| Small-Signal Current Gain (I _C = 50 mA, V _{CE} = 10 V, f = 100 MHz) 2N50 2N50 | | 1.7 2.0 | = | - |
| SWITCHING CHARACTERISTICS | | | <u> </u> | l |
| Turn-On Time (VCE = -30 V, IC ~ 500 mA, I _B ~ 50 mA) | t _{on} | _ | 40 | ns |
| Turn-Off Time (VCE = 30 V, IC ~ 500 mA, IB1 = IB2 ~ 50 mA) | toff | - | 90 | ns |

⁽¹⁾ Pulse Width = 300 μ s, Duty Cycle = 1.0%.

2N5058 2N5059

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | 2N5058 | 2N5059 | Unit |
|---|-----------------------------------|-------------|---------|----------------|
| Collector-Emitter Voltage | VCEO | 300 | 300 250 | |
| Collector-Base Voltage | VCBO | 300 | 300 250 | |
| Emitter-Base Voltage | VEBO | 7.0 | 6.0 | Vdc |
| Collector Current — Continuous | lc | 150 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 6.67 | | Watt mW/℃ |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 33.3 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | ပ္ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|----------------------|-----|------|
| Thermal Resistance, Junction to Case | ReJC | 30 | °CW |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 150 | °C/W |

Refer to 2N3724 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|--|-----------------------|------------|------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (2) (IC = 30 mAdc, IB = 0) | 2N5058 2N5059 | V _(BR) CEO | 300 250 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μ Adc, IE = 0) | 2N5058 2N5059 | V(BR)CBO | 300 250 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | 2N5058 2N5059 | V _{(BR)EBO} | 7.0 6.0 | = ` | Vdc |
| Collector Cutoff Current (VCB = 100 Vdc, IE = 0) (VCB = 100 Vdc, IE = 0, TA | = +125°C) | ІСВО | _ | 0.05 20 | μAdc |
| Emitter Cutoff Current (VBE = 5.0 Vdc, IC = 0) | | ¹ EBO | _ | 10 | nAdc |
| ON CHARACTERISTICS (2) | | | | | |
| DC Current Gain (I _C = 5.0 mAdc, V _{CE} = 25 Vdc) | 2N5058 2N5059 | hFE | 10 10 | = | _ |
| (I _C = 30 mAdc, V _{CE} = 25 Vdc) | 2N5058 2N5059 | | 35 30 | 150 150 | |
| $(I_C = 30 \text{ mAdc}, V_{CE} = 25 \text{ Vdc}, T_A = -55^{\circ}C)$ | 2N5058 | | 10 | - | |
| (IC = 100 mAdc, V _{CE} = 25 Vdc) | 2N5058 2N5059 | | 35 30 | | |
| Collector-Emitter Saturation Voltage (IC = 30 mAdc, I | B = 3.0 mAdc) | V _{CE(sat)} | | 1.0 | Vdc |
| Base-Emitter Saturation Voltage (IC = 30 mAdc, IB = | 3.0 mAdc) | V _{BE(sat)} | _ | 0.85 | Vdc |
| Base-Emitter On Voltage (IC = 30 mAdc, VCE = 25 V | dc) | V _{BE(on)} | | 0.82 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | • | | r |
| Current-Gain — Bandwidth Product (3) (IC = 10 mAdd | c, V _{CE} = 25 Vdc, f = 20 MHz) | fŢ | 30 | 160 | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, IE = 0, f | = 1.0 MHz) | C _{cb} | | 10 | pF |
| Emitter-Base Capacitance (VBE = 0.5 Vdc, IC = 0, f = | : 1.0 MHz) | Ceb | | 75 | pF |

⁽¹⁾ ReJA is measured with the device soldered into a typical printed circuit board.

⁽²⁾ Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

⁽³⁾ fT is defined as the frequency at which the |hfe| extrapolates to unity.

MAXIMUM RATINGS

| MAXIMON RATINGS | | | | | |
|--|-----------------------------------|-------------|-------------|--------|----------------|
| Rating | Symbol | 2N5229 | 2N5230 | 2N5231 | Unit |
| Emitter-Collector Voltage | VECO | 10 | 20 | 30 | Vdc |
| Collector-Base Voltage | VCBO | 15 | 30 | 50 | Vdc |
| Emitter-Base Voltage | VEBO | 15 | 30 | 50 | Vdc |
| Collector Current — Continuous | lc | 50 | | | mAdc |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | | 0.5 2.86 | | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.0 12 | | | Watts mW/°C |
| Operating and Storage Junction | T _J , T _{stg} | -65 to +200 | | | ో |

2N5229 2N5230 2N5231

CASE 26-03, STYLE 1 TO-46 (TO-206AB)

LOW POWER CHOPPER TRANSISTOR

PNP SILICON

| Characteristic | | Symbol | Min | Max | Unit |
|---|--|-----------------|----------------|--------------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Emitter-Collector Breakdown Voltage (I _E = 10 μAdc, I _B = 0) | 2N5229 2N5230 2N5231 | V(BR)ECO | 10 20 30 | = | Vdc |
| Collector-Base Breakdown Voltage {I _C = 10 μAdc, I _E = 0} | 2N5229 2N5230 2N5231 | V(BR)CBO | 15 30 50 | = | Vdc |
| (IE = 10 μAdc, IC = 0) | 2N5229 2N5230 2N5231 | V(BR)EBO | 15 30 50 | = | Vdc |
| Collector Cutoff Current (VCB = 12 Vdc, $I_E = 0$) (VCB = 25 Vdc, $I_E = 0$) (VCB = 40 Vdc, $I_E = 0$) | 2N5229 2N5230 2N5231 | ІСВО | = | 1.0 1.0 1.0 | nAdc |
| Emitter Cutoff Current (VEB = 12 Vdc, C = 0) (VEB = 25 Vdc, C = 0) (VEB = 40 Vdc, C = 0) | 2N5229 2N5230 2N5231 | IEBO | = | 1.0 1.0 1.0 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gein (I _C = 100 µAdc, V _{CE} = 1.0 Vdc) (I _C = 200 µAdc, V _{CE} = 0.5 Vdc) (Inverted Connection) | | hFE | 50 15 | _ | _ |
| Offset Voltage (I _B = 100 μAdc, I _E = 0) (I _B = 1.0 mAdc, I _E = 0) | 2N5229, 2N5230, 2N5231 2N5229, 2N5220, 2N5231 | VEC(ofs) | = | 0.5 0.8 0.8 1.0 | mVdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | 1.0 | |
| Collector-Base Capacitance (VCB = 10 Vdc, IE = 0, f = 140 kHz) | | C _{cb} | - | 5.0 | pF |
| Emitter-Base Capacitance (VEB = 10 Vdc, IC = 0, f = 140 kHz) | | C _{eb} | | 4.0 | pF |
| Small Signal Current Gain (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc, f = 4.0 MHz) | • | hfe | 2.0 | - | _ |

2N5229, 2N5230, 2N5231

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|------------------------|------|---------|-----|-----|------|
| "ON" Series Resistance | | rec(on) | | | Ohms |
| | 5229 | | 1.0 | 6.0 | |
| | 5230 | | 2.0 | 8.0 | |
| 2N | 5231 | | 2.0 | 10 | |



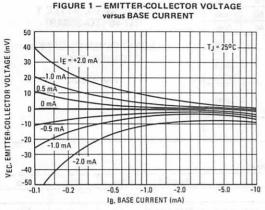
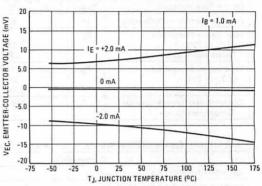


FIGURE 2 — EMITTER-COLLECTOR VOLTAGE versus JUNCTION TEMPERATURE





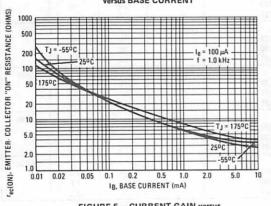


FIGURE 4 – EMITTER-COLLECTOR "ON" RESISTANCE
TEMPERATURE COEFFICIENT versus BASE CURRENT

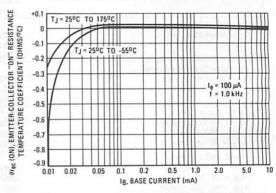


FIGURE 5 – CURRENT GAIN versus COLLECTOR CURRENT

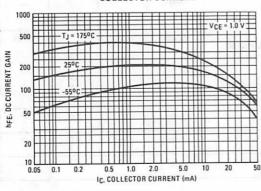


FIGURE 6 – CURRENT GAIN (Inverted Connection)
versus EMITTER CURRENT

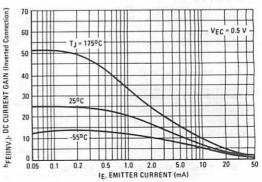


FIGURE 7 - COLLECTOR CUTOFF CURRENT versus
JUNCTION TEMPERATURE

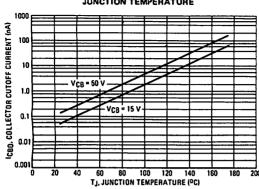


FIGURE 8 — EMITTER CUTOFF CURRENT versus
JUNCTION TEMPERATURE

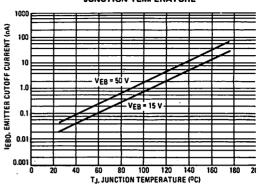


FIGURE 9 — COLLECTOR-EMITTER SATURATION
VOLTAGE Versus COLLECTOR CURRENT

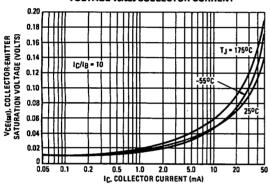
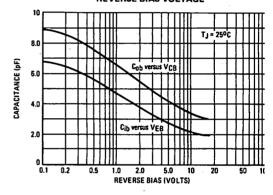


FIGURE 10 – JUNCTION CAPACITANCE Versus
REVERSE BIAS VOLTAGE



2N5320 2N5321

CASE 79, STYLE 1 TO-39 (TO-205AD)

SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | 2N5320 | 2N5321 | Unit |
|---|-----------------------------------|-------------|--------|----------------|
| Collector-Emitter Voltage | VCEO | 75 | 50 | Vdc |
| Collector-Base Voltage | VCBO | 100 | 75 | Vdc |
| Emitter-Base Voltage | VEBO | 7.0 | 5.0 | Vdc |
| Base Current | IВ | 1.0 | | Adc |
| Collector Current — Continuous | lc | 2.0 | | Adc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 10 0.057 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | °C |

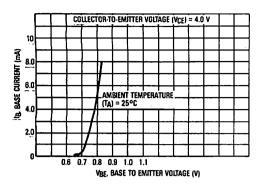
THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|--------------------------------------|--------|------|------|
| Thermal Resistance, Junction to Case | R&JC | 17.5 | •c/w |

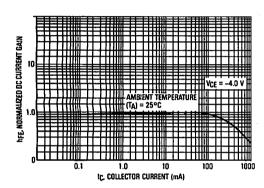
| Characteristic | | Symbol | Min | Max | Unit |
|---|------------------|---------------------|----------|--------------------------|------|
| OFF CHARACTERISTICS | | _ | | | |
| Collector-Emitter Breakdown Voltage (I _C = 100 mAdc, I _B = 0) | 2N5320 2N5321 | V(BR)CEO | 75 50 | | Vdc |
| Collector Cutoff Current (VCE = 100 Vdc, VBE = 1.5 Vdc) (VCE = 70 Vdc, VBE = 1.5 Vdc, T _C = 150°C) (VCE = 75 Vdc, VBE = 1.5 Vdc) (VCE = 45 Vdc, VBE = 1.5 Vdc, T _C = 150°C) | 2N5320 2N5321 | ICEX | = = = | 0.1 5.0 0.1 5.0 | mAdc |
| Emitter Cutoff Current (VBE = 7.0 Vdc, IC = 0) (VBE = 5.0 Vdc, IC = 0) | 2N5320 2N5321 | [‡] EBO | _ | 0.1 0.1 | mAdc |
| ON CHARACTERISTICS(1) | | | | | _ |
| DC Current Gain (I _C = 500 mAdc, V _{CE} = 4.0 Vdc) | 2N5320 2N5321 | hFE | 30 40 | 130 250 | _ |
| (IC = 1.0 Adc, VCE = 2.0 Vdc) | 2N5320 | | 10 | _ | |
| Collector-Emitter Saturation Voltage (IC = 500 mAdc, IB = 50 mAdc) | 2N5320 2N5321 | VCE(sat) | _ | 0.5 0.8 | Vdc |
| Base-Emitter On Voltage (I _C = 500 mAdc, V _{CE} = 4.0 Vdc) | 2N5320 2N5321 | V _{BE(on)} | _ | 1.1 1.4 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Small-Signal Current Gain (IC = 50 mAdc, VCE = 4.0 Vdc, f = 10 MHz) | | h _{fe} | 5 | _ | _ |
| SWITCHING CHARACTERISTICS | | | | | |
| Turn-On Time (V _{CC} = 30 Vdc, ! _C = 500 mAdc, I _{B1} = 50 mAdc) | | ton | _ | 80 | ns |
| Turn-Off Time (V _{CC} = 30 Vdc, I _C = 500 mAdc, I _{B1} = I _{B2} = 50 mAdc) | | ^t off | _ | 800 | ns |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

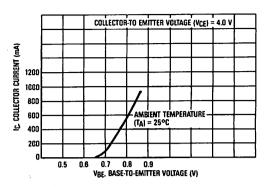
TYPICAL INPUT CHARACTERISTICS



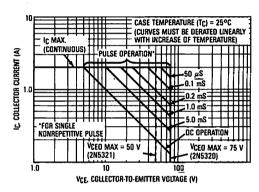
CURRENT GAIN CHARACTERISTICS versus COLLECTOR-EMITTER VOLTAGE



TYPICAL TRANSFER CHARACTERISTICS



MAXIMUM SAFE OPERATING AREAS (SOA)



2N5322 2N5323

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

SWITCHING TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| mounion ibilities | | | | |
|---|-----------------------------------|-------------|--------|---------------|
| Rating | Symbol | 2N5322 | 2N5323 | Unit |
| Collector-Emitter Voltage | VCEO | 75 | 50 | Vdc |
| Collector-Base Voltage | VCBO | 100 | 75 | Vdc |
| Emitter-Base Voltage | VEBO | 7.0 | 5.0 | Vdc |
| Base Current | lΒ | 1.0 | | Adc |
| Collector Current — Continuous | lc | 2.0 | | Adc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 10 0.057 | | Watts W/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | °C |

THERMAL CHARACTERISTICS

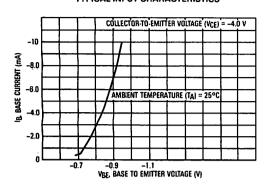
| Characteristic | Symbol | Max | Unit |
|--------------------------------------|--------|------|------|
| Thermal Resistance, Junction to Case | RøJC | 17.5 | °C/W |

| Characteristic | | Symbol | Min | Max | Unit |
|---|------------------|------------------|----------|--------------------------|------|
| OFF CHARACTERISTICS | | | | | • |
| Collector-Emitter Breakdown Voltage(1) (IC = 100 mAdc, IB = 0) | 2N5322 2N5323 | V(BR)CEO | 75 50 | = | Vdc |
| Collector Cutoff Current (VCE = 100 Vdc, VBE = 1.5 Vdc) (VCE = 70 Vdc, VBE = 1.5 Vdc, T _C = 150°C) (VCE = 75 Vdc, VBE = 1.5 Vdc) (VCE = 45 Vdc, VBE = 1.5 Vdc, T _C = 150°C) | 2N5322 2N5323 | ICEX | = | 0.1 5.0 0.1 5.0 | mAdc |
| Emitter Cutoff Current (VBE = 7.0 Vdc, IC = 0) (VBE = 5.0 Vdc, IC = 0) | 2N5322 2N5323 | ^I EBO | = | 0.1 0.1 | mAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain (I _C = 500 mAdc, V _{CE} = 4.0 Vdc) | 2N5322 2N5323 | hFE | 30 40 | 130 250 | _ |
| (IC = 1.0 Adc, VCE = 2.0 Vdc) | 2N5322 | | 10 | _ | |
| Collector-Emitter Saturation Voltage (I _C = 500 mAdc, I _B = 50 mAdc) | 2N5322 2N5323 | VCE(sat) | | 0.7 1.2 | Vdc |
| Base-Emitter On Voltage (IC = 500 mAdc, VCE = 4.0 Vdc) | 2N5322 2N5323 | VBE(on) | _ | 1.1 1.4 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Small-Signal Current Gain (I _C = 50 mAdc, V _{CE} = 4.0 Vdc, f = 10 MHz) | | h _{fe} | 5 | _ | _ |
| SWITCHING CHARACTERISTICS | | | | | |
| Turn-On Time (VCC = 30 Vdc, I _C = 500 mAdc, I _{B1} = 50 mAdc) | | ton | _ | 100 | ns |
| Turn-Off Time (V _{CC} '= 30 Vdc, I _C = 500 mAdc, I _{B1} = I _{B2} = 50 mAdc) | | ^t off | | 1000 | ns |

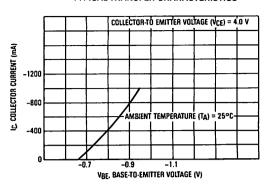
⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

4

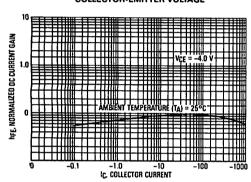
TYPICAL INPUT CHARACTERISTICS



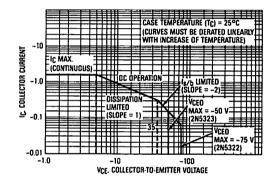
TYPICAL TRANSFER CHARACTERISTICS



CURRENT GAIN CHARACTERISTICS VERSUS COLLECTOR-EMITTER VOLTAGE



MAXIMUM SAFE OPERATING AREAS (SOA)



2N5415, 2N5416

For Specifications, See 2N3439 Data.

2N5581

For Specifications, See 2N2218 Data.

2N5679 2N5680

NPN SILICON

2N5681 2N5682

PNP SILICON

CASE 79-02, STYLE 1 TO-5 (TO-205AA)

GENERAL PURPOSE TRANSISTOR

MAXIMUM RATINGS

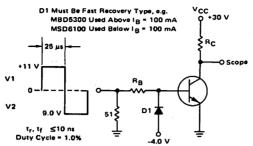
| Rating | Symbol | 2N5679 2N5681 | 2N5680 2N5682 | Unit |
|---|-----------------------------------|------------------|------------------|----------------|
| Collector-Emitter Voltage | VCEO | 100 | 120 | Vdc |
| Collector-Base Voltage | VCBO | 100 | 120 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | | Vdc |
| Base Current | IВ | 0.5 | | Vdc |
| Collector Current — Continuous | lc | 1.0 | | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.7 | | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 10 57 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 65 to | + 200 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max. | Unit |
|---|-------------------|------|------|
| Thermal Resistance, Junction to Case | R ₆ JC | 17.5 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 175 | °C/W |

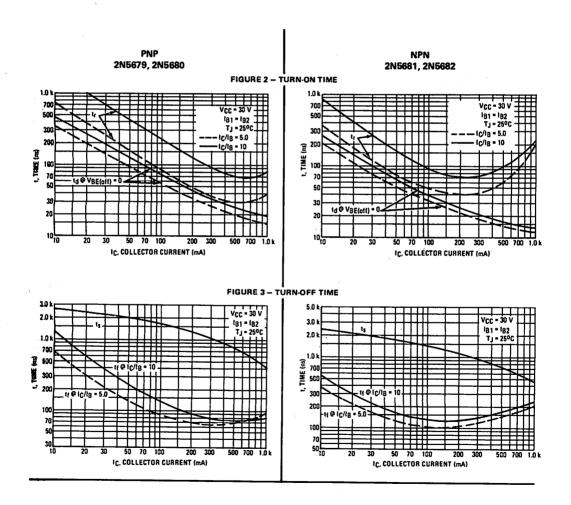
| Characteristic | | Symbol | Min | Max | Unit |
|--|--|----------------------|-------------|--------------------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Sustaining Voltage (I _C = 10 mAdc, I _B = 0) | 2N5679, 2N5681 2N5680, 2N5682 | VCEO(sus) | 100 120 | | Vdc |
| Collector Cutoff Current (VCE = 70 Vdc, Ig = 0) (VCE = 80 Vdc, Ig = 0) | | ICEO | = | 10 10 | μAdc |
| Collector Cutoff Current (VCE = 100 Vdc, VEB = 1.5 Vdc) (VCE = 120 Vdc, VEB = 1.5 Vdc) (VCE = 100 Vdc, VEB = 1.5 Vdc, T _C = 150°C) (VCE = 120 Vdc, VEB = 1.5 Vdc, T _C = 150°C) | 2N5679, 2N5681 2N5680, 2N5682 2N5679, 2N5681 2N5680, 2N5682 | CEX | _ _ _ | 1.0 1.0 1.0 1.0 | μAdc mAdc |
| Collector Cutoff Current (VCB = 100 Vdc, IE = 0) (VCB = 120 Vdc, IE = 0) | 2N5679, 2N5681 2N5680, 2N5682 | СВО | Ξ | 1.0 1.0 | μAdc |
| Emitter Cutoff Current (VEB = 4.0 Vdc, I _C = 0) | | (EBO | _ | 1.0 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 250 mAdc, V _{CE} = 2.0 Vdc) (I _C = 1.0 Adc, V _{CE} = 2.0 Vdc) | | hFE | 40 5.0 | 150 | _ |
| Collector-Emitter Saturation Voltage (IC = 250 mAdc, Ig = 25 mAdc) (IC = 500 mAdc, Ig = 50 mAdc) (IC = 1.0 Adc, Ig = 200 mAdc) | | VCE(sat) | 111 | 0.6 1.0 2.0 | Vdc |
| Base-Emitter Saturation Voltage (IC = 250 mAdc, VCE = 2.0 Vdc) | | V _{BE(sat)} | 1 | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 100 mAdc, VCE = 10 Vdc, f = 10 MHz) | | fτ | 30 | | _ |
| Output Capacitance (VCB = 20 Vdc, I _E = 0, f = 1.0 MHz) | | C _{obo} | _ | 50 | pF |
| Small-Signal Current Gain (IC = 0.2 Adc, VCE = 1.5 Vdc, f = 1.0 kHz) | | hfe | 40 | | _ |

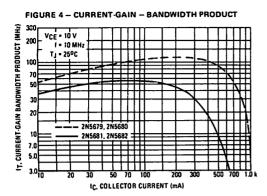
FIGURE 1 - SWITCHING TIMES TEST CIRCUIT

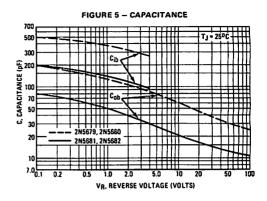


RB and RC Varied to Obtain Desired Current Levels

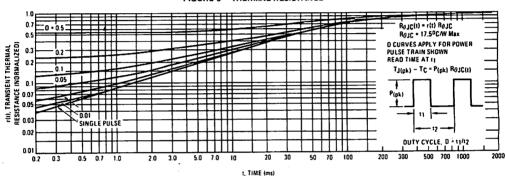
For t_d and t_r, D1 is disconnected and V2 = 0 For PNP test circuit, reverse diods and voltage polarities.













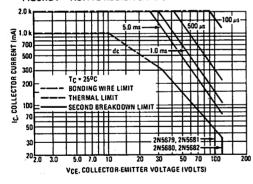
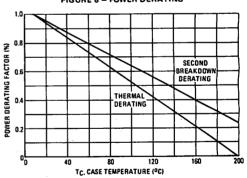
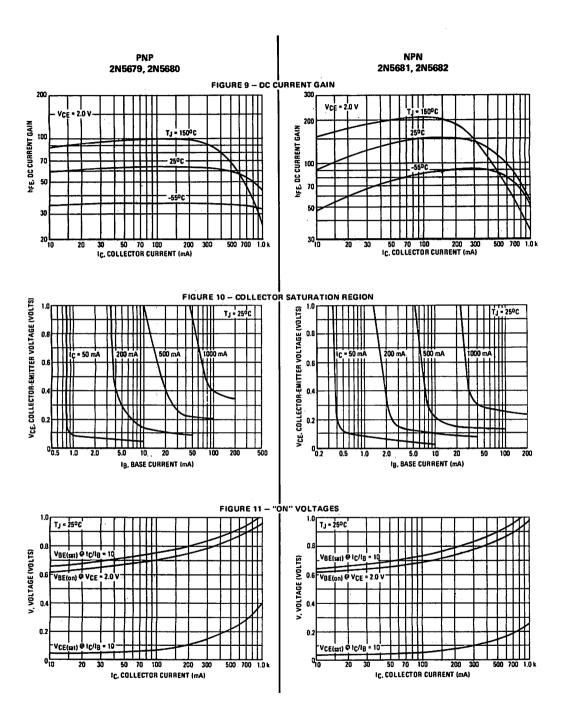


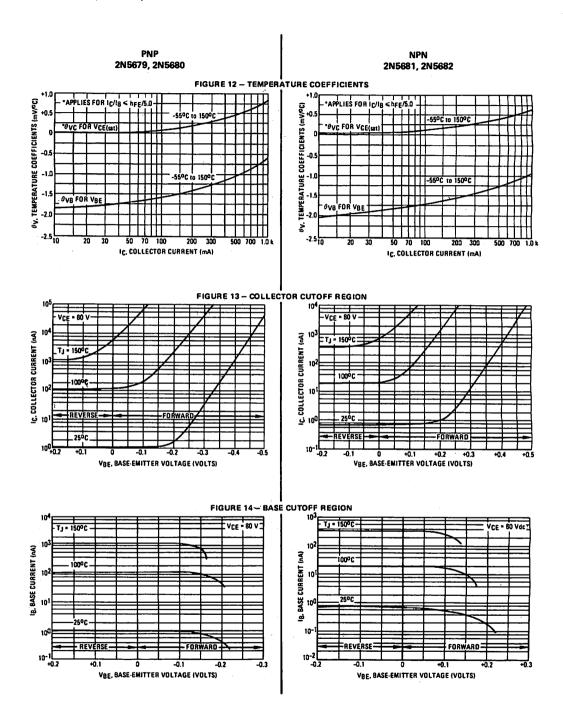
FIGURE 8 - POWER DERATING



There are two limitations on the power handling ability of a transistor: average junction temperature and second breakdown. Safe operating area curves indicate IC - VCE limits of the transistor that must be observed for reliable operation; i.e., the transistor must not be subjected to greater dissipation than the curves indicate.

The data of Figure 7 is based on $T_C=25^{O}C$; $T_{J(pk)}$ is variable depending on power level. Second breakdown pulse limits are valid for duty cycles to 10% provided $T_{J(pk)} \leqslant 200^{O}C$. $T_{J(pk)}$ may be calculated from the data in Figure 6. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown. Second breakdown limitations on tot derate the same as thermal limitations. Allowable current at the voltages shown on Figure 7 may be found at any case temperature by using the appropriate curve on Figure 8.





| MP-MINORI INTERIOR | | | |
|---|----------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 80 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | Vdc |
| Collector Current — Continuous | lc . | 2.0 | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 6.0 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | ° |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|-----|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 35 | °C/W |
| Thermal Resistance, Junction to Ambient | RAIA | 175 | °C/W |

2N5859

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

SWITCHING TRANSISTOR

NPN SILICON

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|----------------|-----------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | V(BR)CEO | 40 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 80 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 μAdc, IC = 0) | V(BR)EBO | 6.0 | - | Vdc |
| Collector Cutoff Current (V _{CE} = 50 Vdc, V _{BE(off)} = 2.0 Vdc) (V _{CE} = 50 Vdc, V _{BE(off)} = 2.0 Vdc, T _A = 75°C) | ICEX | 1 1 | 0.2 5.0 | μAdc |
| Collector Cutoff Current (V _{CB} = 50 Vdc, I _E = 0) (V _{CB} = 50 Vdc, I _E = 0, T _A = 75°C) | lCBO | 1 1 | 0.25 5.0 | μAdc |
| Emitter Cutoff Current (VBE = 5.0 Vdc, IC = 0) | IEBO | _ | 0.1 | μAdc |
| ON CHARACTERISTICS | | | - | |
| DC Current Gain (I _C = 500 mAdc, V_{CE} = 1.0 Vdc) (I _C = 1.0 Adc, V_{CE} = 1.0 Vdc) (I _C = 1.0 Adc, V_{CE} = 1.0 Vdc, T_{A} = -55°C) | hFE | 30 15 10 | 120 100 — | _ |
| Collector-Emitter Saturation Voltage (IC = 500 mAdc, IB = 50 mAdc) (IC = 1.0 Adc, IB = 100 mAdc) | V _{CE(sat)} | 11 | 0.4 0.7 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 500 mAdc, I _B = 50 mAdc) (I _C = 1.0 Adc, I _B = 100 mAdc) | V _{BE(sat)} | 0.8 0.9 | 1.0 1.25 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 10 Vdc, f = 100 MHz) | fτ | 250 | _ | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | C _{cb} | _ | 7.0 | pF |
| Emitter-Base Capacitance (VEB = 0.5 Vdc, IC = 0, f = 100 kHz) | Ceb | _ | 60 | pF |
| SWITCHING CHARACTERISTICS | | | | |
| Delay Time (V _{CC} = 30 Vdc, V _{BE(off)} = 2.0 Vdc, I _C = 1.0 Adc, I _{B1} = 100 mAdc) (Figures 8 and 10) | ^t d | - | 6.0 | ns |
| Rise Time (V _{CC} = 30 Vdc, V _{BE(off)} = 2.0 Vdc, I _C = 1.0 Adc, I _{B1} = 100 mAdc) (Figures 8 and 10) | tr | - | 30 | ns |
| Storage Time (V _{CC} = 30 Vdc, I _C = 1.0 Adc, I _{B1} = I _{B2} = 100 mAdc) (Figures 9 and 11) | ts | _ | 35 | ns |
| Fall Time {V _{CC} = 30 Vdc, I _C = 1.0 Adc, I _{B1} = I _{B2} = 100 mAdc) (Figures 9 and 11) | tf | _ | 35 | ns |

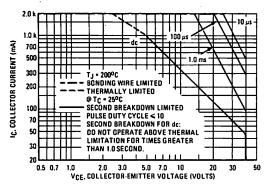
2N5859

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|--|--------|-----|-----|------|
| Turn-On Time $(V_{CC} = 30 \text{ Vdc}, V_{BE(off)} = 2.0 \text{ Vdc}, I_{C} = 1.0 \text{ Adc},$ $I_{B1} = 100 \text{ mAdc})$ (Figures 8 and 10) | ton | _ | 35 | ns |
| Turn-Off Time (V _{CC} = 30 Vdc, I _C = 1.0 Adc, I _{B1} = I _{B2} = 100 mAdc) (Figures 9 and 11) | toff | - | 60 | ns |

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

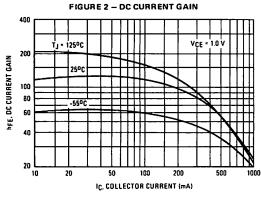
FIGURE 1 - ACTIVE-REGION SAFE OPERATING AREA

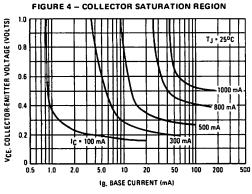


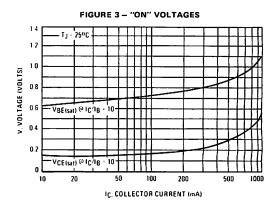
There are two limitations on the power handling ability of a transistor: junction temperature and second breakdown. Safe operating area curves indicate I_C — V_CE limits of the transistor that must be observed for reliable operation; i.e., the transistor must not be subjected to greater dissipation than the curves indicate.

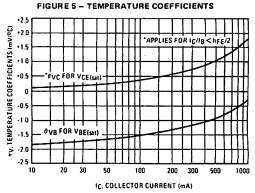
The data of Figure 1 is based on $T_{J(pk)} = 200^{\circ}C$; T_C is variable depending on conditions. Pulse curves are valid for duty cycles of 10% provided $T_{J(pk)} \le 200^{\circ}C$. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

TYPICAL DC CHARACTERISTICS

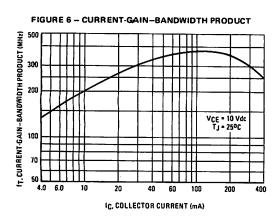


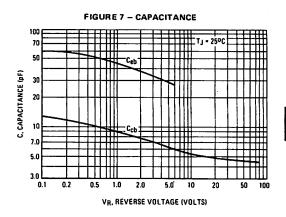


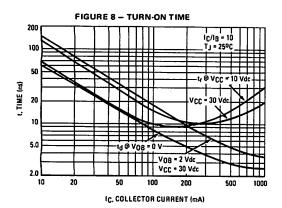


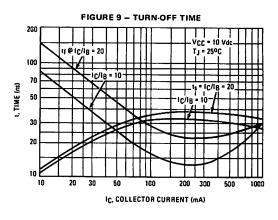


TYPICAL DYNAMIC CHARACTERISTICS

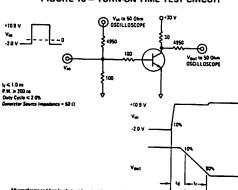




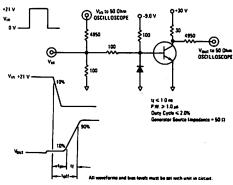












2N5861

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MIAXIMUM RATINGS | | | |
|---|----------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 50 | Vdc |
| Collector-Base Voltage | VCBO | 100 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | Vdc |
| Collector Current — Continuous | lc . | 2.0 | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 6.0 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | Tj, T _{stg} | -65 to +200 | °C |

| • | Characteristic | Symbol | Min | Max | Unit |
|--|--|----------------------|----------|-----------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdov (IC = 10 mAdc, IB = 0) | vn Voltage(1) | V(BR)CEO | 50 | _ | Vdc |
| Collector-Base Breakdown (IC = 100 µAdc, IE = 0) | | V(BR)CBO | 100 | - | Vdc |
| Emitter-Base Breakdown V (IE = 10 µAdc, IC = 0) | /oltage | V(BR)EBO | 6.0 | - | Vdc |
| Collector Cutoff Current (VCE = 50 Vdc, VBE(off) (VCE = 50 Vdc, VBE(off) | = 2.0 Vdc) = 2.0 Vdc, T _A = 75°C) | ICEX | _ | 0.3 10 | μAdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) (VCB = 50 Vdc, IE = 0, | | СВО | | 0.3 10 | μAdc |
| Emitter Cutoff Current (VBE = 5.0 Vdc, IC = 0) | | l _{EBO} | _ | 0.1 | μAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain (IC = 500 mAdc, VCE = (IC = 500 mAdc, VCE = | | hFE | 25 10 | 100 | _ |
| Collector-Emitter Saturation | on Voltage | V _{CE(sat)} | - | 0.5 | Vdc |
| Base-Emitter Saturation V | | V _{BE(sat)} | 0.8 | 1.1 | Vdc |
| SMALL-SIGNAL CHARAC | TERISTICS | | | | |
| Current-Gain — Bandwidt (IC = 50 mAdc, VCE = | | fŢ | 200 | _ | MHz |
| Collector-Base Capacitano (VCB = 10 Vdc, lg = 0, | | C _{cb} | _ | 7.0 | pF |
| Emitter-Base Capacitance (VBE = 0.5 Vdc, IC = 0 | | C _{eb} | _ | 60 | pF |
| SWITCHING CHARACTER | RISTICS | | | | |
| Turn-On Time | (V _{CC} = 30 Vdc, V _{BE(off)} = 2.0 Vdc, | ton | | 25 | ns |
| Delay Time | IC = 500 mAdc, Ig1 = 50 mAdc) | t _d | | 8.0 | ns |
| Rise Time | | t _r | _ | 18 | ns |

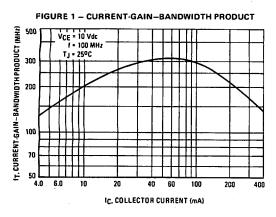
2N5861

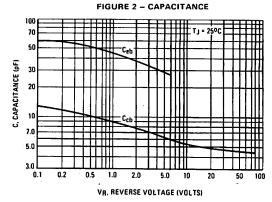
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

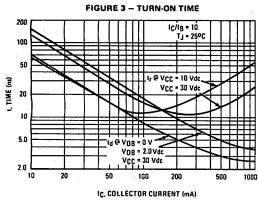
| | Characteristic | Symbol | Min | Max | Unit |
|---------------|---|--------|-----|-----|------|
| Turn-Off Time | (V _{CC} = 30 Vdc, I _C = 500 mAdc, | toff | _ | 60 | ns |
| Storage Time | l _{B1} = l _{B2} = 50 mAdc) | ts | | 35 | ns |
| Fall Time | | tf | _ | 35 | ns |

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%

TYPICAL DYNAMIC CHARACTERISTICS







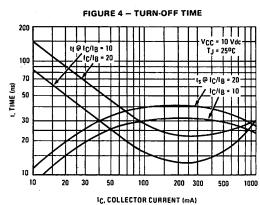
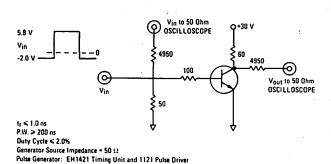
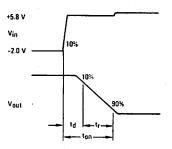


FIGURE 5 - TURN-ON TIME TEST CIRCUIT



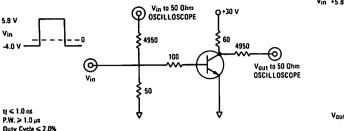


Vin during ton interval must be +5.8 V.
All waveforms and bias levels must be set with unit in circuit.

SMALL-SIGNAL DEVICES

Oscilloscope: Tektronix 661 Sampling Scope

FIGURE 6 - TURN-OFF TIME TEST CIRCUIT

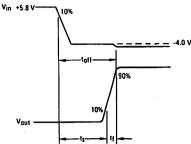


Buty Cycle < 2.0%

Generator Source Impedance = 50 Ω

Pulse Generator: EH1421 Timing Unit and 1121 Pulse Driver

Oscilloscope: Tektronix 661 Sampling Scope



Vin during toff interval must be -4.0 V. All waveforms and bias levels must be set with unit in circuit.

FIGURE 7 - DC CURRENT GAIN

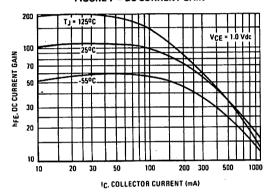


FIGURE 8 - "ON" VOLTAGES

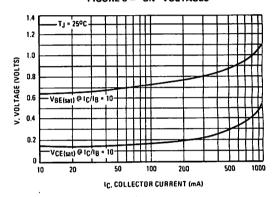
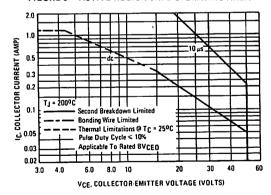


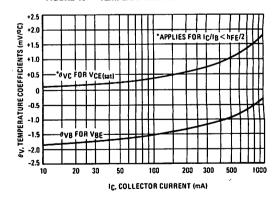
FIGURE 9 - ACTIVE-REGION SAFE OPERATING AREA



There are two limitations on the power handling ability of a transistor: junction temperature and secondary breakdown. Safe operating area curves indicate I_C-V_{CE} limits of the transistor that must be observed for reliable operation, i.e., the transistor must not be subjected to greater dissipation than the curves indicate.

The date of Figure 9 is based on $T_{J(pk)} = 200^{\circ}C$; T_C is variable depending on conditions. Pulse curves are valid for duty cycles of 10% provided $T_{J(pk)} \le 200^{\circ}C$. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by secondary breakdown.

FIGURE 10 - TEMPERATURE COEFFICIENTS



2N6430 2N6431

CASE 22, STYLE 1 TO-18 (TO-206AA)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | 2N6430 | 2N6431 | Unit |
|---|----------------------|-------------|--------|----------------|
| Collector-Emitter Voltage | VCEO | 200 | 300 | Vdc |
| Collector-Base Voltage | VCBO | 200 | 300 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | | · Vdc |
| Collector Current — Continuous | lc lc | 50 | | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 500 2.86 | | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.8 10.3 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | Tj, T _{stg} | -65 to +200 | | · °C |

| | Symbol | Min | Max | Unit |
|------------------|--------------------------------------|--|--|---|
| | | | | |
| 2N6430 2N6431 | V(BR)CEO | 200 300 | = | Vdc |
| 2N6430 2N6431 | V(BR)CBO | 200 300 | _ | Vdc |
| | V(BR)EBO | 6.0 | | Vdc |
| 2N6430 2N6431 | Ісво | _ | 0.1 0.1 | μAdc |
| | IEBO | | 0.1 | μAdc |
| | | | | |
| | hFE | 25 40 50 | _ _ _ 200 | _ |
| | VCE(sat) | _ | 0.5 | Vdc |
| | V _{BE(sat)} | - | 0.9 | Vdc |
| | | | <u> </u> | 4 |
| | fτ | 50 | 500 | MHz |
| | C _{cb} | _ | 4.0 | pF |
| | 2N6431 2N6430 2N6431 2N6430 | 2N6430 2N6431 2N6430 2N6431 V(BR)CBO V(BR)EBO V(BR)EBO ICBO ICBO IEBO VCE(sat) VBE(sat) | 2N6430 2N6431 2N6430 2N6431 V(BR)CBO 200 300 V(BR)EBO 6.0 V(BR)EBO 6.0 LCBO 2N6431 LEBO - hFE 25 40 50 VCE(sat) - VBE(sat) - fT 50 | 2N6430 2N6431 2N6430 2N6431 V(BR)CBO 200 300 2N6431 V(BR)EBO 6.0 2N6430 2N6431 ICBO 1EBO 0.1 1EBO 0.1 NFE 25 40 50 200 VCE(sat) 0.5 VBE(sat) 0.9 |

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

2N6432 2N6433

CASE 22, STYLE 1 TO-18 (TO-206AA)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| MINAMINO IN THE THEO | | | | |
|---|-----------------------------------|--------|-----------|----------------|
| Rating | Symbol | 2N6432 | 2N6433 | Unit |
| Collector-Emitter Voltage | VCEO | 200 | 300 | Vdc |
| Collector-Base Voltage | VCBO | 200 | 300 | Vdc |
| Emitter-Base Voltage | VEBO | - 5 | .0 | Vdc |
| Collector Current — Continuous | lc | 5 | 00 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | | 00 86 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | | .8 0.3 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to | +200 | °C |

Refer to 2N3743 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|------------------|----------------------|----------------|---------------------------------------|----------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | 2N6432 2N6433 | V(BR)CEO | 200 300 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.1 mAdc, IE = 0) | 2N6432 2N6433 | V(BR)CBO | 200 300 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 0.1 mAdc, I _C = 0) | | V(BR)EBO | 5.0 | | Vdc |
| Collector Cutoff Current (VCB = 160 Vdc) (VCB = 200 Vdc) | 2N6432 2N6433 | ICBO | <u>-</u> | 0.25 0.25 | μAdc |
| Emitter Cutoff Current (VEB = 3.0 Vdc, IC = 0) | | !EBO | _ | 0.1 | μAdc |
| ON CHARACTERISTICS | | | | | <u>,</u> |
| DC Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc) (IC = 10 mAdc, VCE = 10 Vdc) (IC = 30 mAdc, VCE = 10 Vdc) | | hFE | 25 40 30 | _ 150 | _ |
| Collector-Emitter Saturation Voltage (I _C = 20 mAdc, I _B = 2.0 mAdc) | | V _{CE(sat)} | | 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 20 mAdc, IB = 2.0 mAdc) | | V _{BE(sat)} | <u> </u> | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | · · · · · · · · · · · · · · · · · · · | · · |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 20 MHz) | _ +_ + | ft . | 50 | 500 | MHz |
| Collector-Base Capacitance (VCB = 20 Vdc, IE = 0, f = 1.0 MHz) | | C _{cb} | _ | 6.0 | pF |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| Rating | Symbol | MM420 | MM421 | Unit | |
|---|----------------------|------------|-------|----------------|--|
| Collector-Emitter Voltage | VCEO | 250 | 325 | Vdc | |
| Collector-Base Voltage | VCBO | 275 | 350 | Vdc | |
| Emitter-Base Voltage | VEBO | 6.0 | 6.0 | Vdc | |
| Base Current | IВ | 100 | 100 | mA | |
| Collector Current — Continuous | lc | 100 | 500 | mA | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 800 5.3 | | mW mW/°C | |
| Total Device Dissipation @ T _A = 75°C Derate above 75°C | PD | 2.5 25 | | Watts mW/°C | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | - 65 to | + 175 | °C | |

MM420 MM421

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

TRANSISTOR

NPN SILICON

Refer to 2N3439 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|----------------|------------------|----------------|-------------|----------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Sustaining Voltage(1) (I _C = 10 mA, I _B = 0) | MM420 MM421 | VCEO(sus) | 250 325 | = 1 | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μAdc) | MM420 MM421 | V(BR)CBO | 275 350 | = | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc) | | V(BR)EBO | 6 | - | Vdc |
| Collector Cutoff Current (VCE = 250 Vdc, t _B = 0) (VCE = 325 Vdc, t _B = 0) | MM420 MM421 | ICEO | = | 1.0 | mAdc |
| Collector Cutoff Current (VBE = 275 Vdc, IE = 0) (VBE = 350 Vdc, IE = 0) | MM420 MM421 | ICBO | _ | 100 | μAdc |
| ON CHARACTERISTICS | ; | | | | <u> </u> |
| DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 20 Vdc) (I _C = 10 mAdc, V _{CE} = 20 Vdc) (I _C = 30 mAdc, V _{CE} = 20 Vdc) | | hFE | 15 25 25 | | |
| Collector-Emitter Saturation Voltage (IC = 30 mAdc, IB = 3.0 mAdc) | | VCE(sat) | | 5.0 | Vdc |
| Base-Emitter On Voltage (IC = 30 mA, VCE = 20 V) | | VBE(on) | _ | 1.0 | ٧ |
| SMALL-SIGNAL CHARACTERISTICS | | | | · | · |
| Current-Gain — Bandwidth Product (IC = 10 mA, V _{CE} = 20 V, f = 10 MHz) | | fτ | 15 | _ | MHz |
| Output Capacitance (V _{CB} = 20 V, f = 100 kHz) | (Common Base) | C _{obo} | _ | 12 | pF |

⁽¹⁾ PW ≤ 300 µsec, Duty Cycle ≤ 2.0%.

MM1505

CASE 27-02, STYLE 1 TO-52 (TO-206AC)

SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MAXIMON NATINGS | _ | | |
|---|-----------------------------------|--------------|--------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage(1) | VCEO | 6.0 | Vdc |
| Collector-Emitter Voltage | VCES | 11 | Vdc |
| Collector-Base Voltage | VCBO | 15 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | lC | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.30 1.71 | Watt mW/℃ |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |
| Lead Temperature (Soldering, 60 second time limit) | TL | 300 | င့ |

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|--------------------|-----------------------------|------|
| OFF CHARACTERISTICS | | | | · |
| Collector-Emitter Breakdown Voltage (I _C = 10 μAdc, V _{BE} = 0) | V(BR)CES | 11 | _ | Vdc |
| Collector-Emitter Sustaining Voltage(2) (I _C = 10 mAdc, I _B = 0) | VCEO(sus) | 6.0 | - | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | V(BR)CBO | 15 | <u> </u> | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 4.0 | | Vdc |
| Collector Cutoff Current (V _{CE} = 11 Vdc, V _{BE} = 0) (V _{CE} = 5.0 Vdc, V _{BE} = 0) (V _{CE} = 5.0 Vdc, V _{BE} = 0, T _A = +85°C) | ICES | = | 10 0.1 5.0 | μAdc |
| Base Cutoff Current (VCE = 11 Vdc, VEB(off) = 0) | IBL | | 10 | μAdc |
| ON CHARACTERISTICS(2) | | | | |
| DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 0.4 Vdc) (I _C = 10 mAdc, V _{CE} = 0.4 Vdc) (I _C = 30 mAdc, V _{CE} = 0.4 Vdc) | hFE | 15 25 15 | 125 — | _ |
| Collector-Emitter Saturation Voltage (IC = 1.0 mAdc, IB = 0.1 mAdc) (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 30 mAdc, IB = 3.0 mAdc) (IC = 10 mAdc, IB = 1.0 mAdc, TA = 85°C) | VCE(sat) | <u>-</u> - - | 0.25 0.25 0.38 0.4 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 1.0 mAdc, I _B = 0.1 mAdc) (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 30 mAdc, I _B = 3.0 mAdc) | V _{BE(sat)} | 0.68 0.75 — | 0.85 0.95 1.3 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 4.0 Vdc, f = 100 MHz) | fT | 600 | | MHz |
| Output Capacitance (VCB = 5.0 Vdc, I _E = 0, f = 140 kHz) | C _{obo} | _ | 3.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 140 kHz) | C _{ibo} | _ | 2.0 | pF |
| SWITCHING CHARACTERISTICS | | | | |
| Storage Time (IC = $I_{B1} \sim I_{B2} = 5.0 \text{ mAdc}$) | t _S | _ | 6.0 | ns |
| Turn-On Time (V _{CC} = 1.0 Vdc, V _{BE(off)} = 1.0 Vdc, I _C = 10 mAdc, I _{B1} \approx 2.0 mAdc) | ton | - | 12 | ns |
| Turn-Off Time (V _{CC} = 1.0 Vdc, I _C = 10 mAdc, I _{B1} ~ I _{B2} ~ 1.0 mAdc) | toff | _ | 12 | ns |

Applicable from 0.01 mAdc to 10 mAdc (Pulsed).
 Pulse Test: Pulse Length = 300 μs, Duty Cycle ≤ 2.0%.

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|-------------|
| Collector-Emitter Voltage | V _{CEO(sus)} | 6.0 | Vdc |
| Collector-Base Voltage | VCBO | 15 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | lc | 150 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 1.71 | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

MM1748,A

CASE 27, STYLE 1 TO-52 (TO-206AC)

SWITCHING TRANSISTOR

NPN SILICON

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|----------------------|-----|------|
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 583 | °C/W |

(1) Raja is measured with the device soldered into a typical printed circuit board.

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|------------------------------|----------------------|------------|------------|-----------|------|
| OFF CHARACTERISTICS | | | | | | • |
| Collector-Emitter Sustaining Voltage(2) (IC = 10 mAdc, IB | = 0) | VCEO(sus) | 6.0 | | Γ – | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 μ Adc, IE = 0) | | V(BR)CBO | 15 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 μ Adc, IC = 0) | | V(BR)EBO | 4.0 | | _ | Vdc |
| Collector Cutoff Current (VCB = 5.0 Vdc, I _E = 0) | MM1748 MM1748A | СВО | = | = | 50 5.0 | nAde |
| (V _{CB} = 5.0 Vdc, I _E = 0, T _A = 150°C) ON CHARACTERISTICS(2) | Both Devices | | | | 5.0 | μAdd |
| DC Current Gain (IC = 10 mAdc, VCE = 0.5 Vdc) | MM1748 MM1748A | hFE | 20 30 | 50 55 | 120 90 | - |
| (I _C = 10 mAdc, V _{CE} = 0.5 Vdc, T _A = -55°C) (I _C = 30 mAdc, V _{CE} = 1.0 Vdc) | Both Devices Both Devices | | 10 15 | 20 20 | 1 - | |
| Collector-Emitter Saturation Voltage (IC = 3.0 mAdc, IB = | | V _{CE(sat)} | | 0.2 | 0.3 | Vdc |
| Base-Emitter Saturation Voltage (IC = 3.0 mAdc, IB = 0.15 | mAdc) | V _{BE(sat)} | 0.7 | 0.78 | 0.85 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | - | |
| Current-Gain — Bandwidth Product (IC = 5.0 mAdc, VCE = 4.0 Vdc, f = 100 MHz) | MM1748 MM1748A | fτ | 600 800 | 750 850 | _ | MHz |
| Output Capacitance (VCB = 5.0 Vdc, I_E = 0, f = 140 kHz) | | C _{obo} | _ | 2.0 | 3.0 | рF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 140 kHz) | | Cibo | _ | 1.8 | 2.0 | pF |
| SWITCHING CHARACTERISTICS | | | | | | |
| Storage Time (V _{CC} = 3.0 Vdc, I _C = 5.0 mAdc, I _{B1} = I _{B2} = 5.0 mAdc) | | t _S | _ | 4.0 | 6.0 | ns |
| Furn-On Time (VCC = 1.0 Vdc, VBE(off) = 1.0 Vdc, I _C = 10 mAdc, I _{B1} = 2.0 mAdc, I _{B2} = 1.0 mAdc) | | ton | _ | 12 | 15 | ns |
| urn-Off Time (VCC = 1.0 Vdc, I _C = 10 mAdc, I _{B1} = I _{B2} = 1.0 mAdc) | | toff | _ | 12 | 15 | ns |

MM2005

CASE 22-03, STYLE 1 TO-18 (TO-206AA)

AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| MANIMONI PATTIAGO | | | |
|--|-----------------------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Base Voltage | VCBO | 25 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | lc | 600 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 400 2.28 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.4 8.0 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

Refer to 2N2904 for graphs.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------------------|-----|-----|--------------|------|
| OFF CHARACTERISTICS | | | | | , |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, Ig = 0) | V(BR)CEO | 20 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 25 | _ | | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 µAdc, IC = 0) | V(BR)EBO | 4.0 | _ | | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, I _E = 0) | ICBO | _ | | 0.5 | μAdc |
| ON CHARACTERISTICS(1) | | | · | , | , |
| DC Current Gain (IC = 150 mAdc, VCE = 10 Vdc) | hFE | 100 | 200 | 400 | |
| Collector-Emitter Saturation Voltage (IC = 150 mAdc, Ig = 15 mAdc) | VCE(sat) | | 0.3 | 1.0 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc) | V _{BE(sat)} | _ | 0.7 | 2.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | | 6.0 | 15 | pF |
| SWITCHING CHARACTERISTICS | · | | · | | |
| Turn-On Time (V _{CC} = 30 Vdc, I _C = 150 mAdc, I _{B1} = 15 mAdc) | ton | _ | 20 | 45 | μ8 |
| Turn-Off Time (V _{CC} = 6.0 Vdc, I _C = 150 mAdc, I _{B1} = I _{B2} = 15 mAdc) | ^t off | _ | 85 | 100 | μS |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| Rating | Symbol | MM2258 | MM2259 MM2260 | Unit |
|---|-----------------------------------|-------------|------------------|----------------|
| Collector-Emitter Voltage | VCEO | 120 | 175 | Vdc |
| Collector-Base Voltage | VCBO | 120 | 175 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc |
| Collector Current — Continuous | ļС | 500 | 300 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | P _D | 1.0 5.71 | | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | •€ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | | MM2259 MM2260 | Unit |
|---|------------------|---|------------------|------|
| Thermal Resistance, Junction to Case | ReJC | 3 | 5 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{BJA} | 1 | 75 | °C/W |

MM2258 MM2259 MM2260

CASE 31-03, STYLE 1 TO-5 (TO-205AA)

TRANSISTOR

NPN SILICON

Refer to 2N3498 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|---|---------------------------------------|----------------------|------------|------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | MM2258 MM2259, MM2260 | V(BR)CEO | 120 175 | = | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | MM2258 MM2259, MM2260 | V(BR)CBO | 120 175 | = | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | | Vdc |
| Collector Cutoff Current (VCB = 75 V, IE = 0) (VCB = 75 V, IE = 0, 50°C) | | ICBO | = | .050 50 | μAdc |
| Emitter Cutoff Current (VEB = 4.0 Vdc, IC = 0) | | ¹ EBO | _ | 25 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 1.0 mAde, VCE = 10 Vde) | MM2269 MM2268, MM2260 | pŁE | 25 50 | = | _ |
| (I _C = 10 mAdc, V _{CE} = 10 Vdc) | MM2259 MM2258, MM2260 | | 35 50 | = | |
| (I _C = 50 mAdc, V _{CE} = 10 Vdc) | MM2269 MM2258, MM2260 | | 35 50 | _ | |
| Collector-Emitter Saturation Voltage (IC = 25 mAdc, IB = 2.5 mAdc) | | VCE(sat) | _ | 0.4 | Vdc |
| Base-Emitter Saturation Voltage (IC = 25 mAdc, IB = 2.5 mAdc) | · · · · · · · · · · · · · · · · · · · | V _{BE(sat)} | _ | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | , | | | |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 100 kHz) | MM2258 MM2259, MM2260 | C _{obo} | | 9.0 8.0 | pF |
| Collector-Base Capacitance (VCB = 25 Vdc, IC = 10 mAdc) | MM2258 MM2259, MM2260 | C _{cb} | | 5.0 4.5 | pF |
| Magnitude of Forward Current Transfer Ratio, Cor (VCE = 25 Vdc, IC = 20 mAdc, f = 100 MHz) | | h _{fe} | 1.5 | — . | _ |

(1) Pulse Test: PW \leq 300 μ s, Duty Cycle \leq 2.0%.

MM3000 thru MM3003

CASE 79, STYLE 1 TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | MM3000 | MM3001 | MM3002 | MM3003 | Unit |
|--|----------------------|-------------|--------|--------|----------------|---------------|
| Collector-Emitter Voltage | VCEO | 100 | 150 | 200 | 250 | Vdc |
| Emitter-Base Voltage | VEBO | | 5 | .0 | | Vdc |
| Collector Current — Continuous | lc | 200 | 200 | 50 | 50 | mAdc |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 1.0 5.71 | | | | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | | | Watts mW/°C | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | | -65 t | o +200 | | •€ |

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|---|--------------------------------------|------------------|---------------------------------|-------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, Ig = 0) | MM3000 MM3001 MM3002 MM3003 | V(BR)CEO | 100 100 150 200 250 | - - - | Vdc |
| (IE = 10 hVdc' IC = 0) Emitter-Base Breakdown Aoltage | | V(BR)EBO | 5.0 | - | Vdc |
| Collector Cutoff Current (V _{CB} = 60 Vdc, I _E = 0) (V _{CB} = 75 Vdc, I _E = 0) (V _{CB} = 100 Vdc; I _E = 0) | MM3000 MM3001 MM3002, MM3003 | ICBO | <u>-</u> | 1.0 1.0 5.0 | μAdc |
| ON CHARACTERISTICS | | | | | , |
| DC Current Gain (IC = 10 mAdc, VCE = 10 Vdc) | | hFE | 20 | | |
| SMALL-SIGNAL CHARACTERISTICS | | | | , | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz) | | ĺΤ | 150 | | MHz |
| Output Capacitance (VCB = 20 Vdc/Ig = 0, f = 100 kHz) | MM3000, MM3001 MM3002, MM3003 | C _{obo} | = | 7.0 15 | pF- |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| MACHINO IN TEATHING | | | | | |
|--|----------------------|-------------|-------------|--------|----------------|
| Rating | Symbol | MM3005 | MM3006 | MM3007 | Unit |
| Collector-Emitter Voltage | VCEO | 60 | 80 | 100 | Vdc |
| Collector-Base Voltage | VCBO | 80 | 100 | 120 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | | | Vdc |
| Collector Current — Continuous | lc | 2.5 | | | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | | 1.0 5.71 | | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 8.0 45.6 | | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | - | 65 to +2 | 00 | ů |

MM3005 MM3006 MM3007

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

AUDIO TRANSISTOR

NPN SILICON

| Characteristic | | Symbol | Min | Max | Unit |
|---|---|------------------|----------------------|--------------------------|--------------|
| OFF CHARACTERISTICS | · | | | · | I |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | MM3005 MM3006 MM3007 | V(BR)CEO | 60 80 100 | = | Vdc |
| Collector-Base Breakdown Voltage | MM3005 MM3006 MM3007 | V(BR)CBO | 80 100 120 | = | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 60 Vdc, I _E = 0) (V _{CB} = 80 Vdc, I _E = 0) (V _{CB} = 100 Vdc, I _E = 0) | MM3005 MM3006 MM3007 | ІСВО | <u>-</u> | 100 100 100 | nAdc |
| Emitter Cutoff Current (VBE = 4.0 Vdc, I _C = 0) | | IEBO | _ | 100 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 1.0 mAdc, V _{CE} = 1.0 Vdc) (IC = 150 mAdc, V _{CE} = 1.0 Vdc) (IC = 200 mAdc, V _{CE} = 1.0 Vdc) (IC = 250 mAdc, V _{CE} = 1.0 Vdc) | All Types MM3005 MM3006 MM3007 | hFE | 40 50 50 50 | 250 250 250 250 | - |
| Collector-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) | | VCE(sat) | _ | 0.35 | Vdc |
| Base-Emitter On Voltage (IC = 150 mAdc, VCE = 1.0 Vdc) | | VBE(on) | 0.60 | 0.75 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product(1) (IC = 50 mAdc, VCE = 10 Vdc, f = 20 MHz) | | fτ | 50 | | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 100 kHz) | | C _{obo} | _ | 15 | pF |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MM3008 MM3009

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

TRANSISTOR

NPN SILICON

| MAXIMUM RATINGS | | | | |
|---|-----------------------------------|-------------|--------|----------------|
| Rating | Symbol | MM3008 | MM3009 | Unit |
| Collector-Emitter Voltage | VCEO | 120 | 180 | Vdc |
| Emitter-Base Voltage | VEBO | 6 | .0 | Vdc |
| Collector Current — Continuous | lc | 400 n | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.71 | | Watt mW/℃ |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 4.0 22.8 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to | +200 | ూ |

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|---|------------------|------------------|----------------|------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | MM3008 MM3009 | V(BR)CEO | 120 180 | | Vđc |
| Emitter-Base Breakdown Voltage (IE = 10 μAdc, IC = 0) | | V(BR)EBO | 6.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 120 Vdc, IE = 0) (VCB = 180 Vdc, IE = 0) | MM3008 MM3009 | ІСВО | _ | 0.1 0.1 | μAdc |
| Emitter Cutoff Current (VBE = 4.0 Vdc, IC = 0) | | IEBO | | 0.1 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc) (IC = 10 mAdc, VCE = 10 Vdc) (IC = 30 mAdc, VCE = 10 Vdc) | | hFE | 30 40 30 | = | _ |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 20 mAdc, VCE = 20 Vdc, f = 20 MHz) | | fτ | 50 | | MHz |
| Output Capacitance (VCB = 20 Vdc, IE = 0, f = 1.0 MHz) | | C _{obo} | _ | 4.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = 0, f = 1.0 MHz) | | C _{ibo} | | 20 | pF |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Base Voltage | V _{CBO} | 50 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | ıc | 1.5 | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.71 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | ℃ |

THERMAL CHARACTERISTICS

| *************************************** | | | |
|---|------------------|-----|------|
| Characteristic | Symbol | Max | Unit |
| Thermal Resistance, Junction to Case | R _{ØJC} | 35 | °C/W |
| Thermal Resistance, Junction to Ambient | RAIA | 175 | °C/W |

MM3726

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

SWITCHING TRANSISTOR

PNP SILICON

Refer to 2N3467 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|----------------------|----------|------------|-------------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | V(BR)CEO | 50 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 40 Vdc, IE = 0) | ICBO | | 0.1 | μAdc · |
| ON CHARACTERISTICS(1) | | | | |
| DC Current Gain (IC = 500 mAdc, VCE = 2.0 Vdc) (IC = 1.0 Adc, VCE = 5.0 Vdc) | hFE | 30 15 | 120 — | _ |
| Collector-Emitter Saturation Voltage (IC = 500 mAdc, IB = 50 mAdc) (IC = 1.0 Adc, IB = 100 mAdc) | VCE(sat) | _ | 0.6 1.2 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 500 mAdc, I _B = 50 mAdc) (I _C = 1.0 Adc, I _B = 100 mAdc) | V _{BE(sat)} | 0.8 | 1.1 1.3 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | • | |
| Current-Gain — Bendwidth Product(1) (I _C = 50 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | fτ | 200 | _ | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, $I_E = 0$, $f = 100$ kHz, emitter guarded) | C _{cb} | _ | 10 | pF |
| Emitter-Base Capacitance (VBE = 0.5 Vdc, IC = 0, f = 100 kHz, collector guarded) | C _{eb} | _ | 80 | pF |
| SWITCHING CHARACTERISTICS | | | | |
| Turn-On Time (V _{CC} = 30 Vdc, V _{BE} (off) = 2.0 Vdc, I _C = 500 mAdc, I _{B1} = 50 mAdc, R _B = 200 ohms, R _L = 60 ohms) | ton | _ | 30 | ns |
| Turn-Off Time (V _{CC} = 30 Vdc, I_C = 500 mAdc, I_{B1} = I_{B2} = 50 mAdc, I_{B} = 200 ohms, I_{C} = 60 ohms) | toff | _ | 90 | ns |
| Turn-On Time (VCC = 30 Vdc, VBE = 2.0 Vdc, I _C = 1.0 Adc, I _{BV} = 100 mAdc, R _B = 100 ohms, R _L = 30 ohms) | ^t on | _ | 35 | ns |
| Turn-Off Time ($V_{CC}=30\ V_{dc}$, $I_{C}=1.0\ Adc$, $I_{B1}=I_{B2}=100\ mAdc$, $R_{B}=100\ ohms$, $R_{L}=30\ ohms$) | toff | - | 60 | ns |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MM3903 MM3904

CASE 27-02, STYLE 1 TO-52 (TO-206AC)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|----------------------|-------------|-------------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | VCBO | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | Vdc |
| Collector Current — Continuous | ΙC | 200 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 200 2.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C -Derate above 25°C | PD | 500 5.0 | mW mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +125 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|-----|------|
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 490 | °C/W |

| Characteristic | | Symbol | Min | Max | Unit |
|--|------------------|----------------------|-----------|--------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 m | Adc, Ig = 0) | V(BR)CEO | 40 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, I | E = 0) | V(BR)CBO | 60 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 μAdc, IC | | V(BR)EBO | 6.0 | _ | Vdc |
| Base Cutoff Current (VCE = 30 Vdc, VEB(off) = 3.0 | Vdc) | IBEV | _ | 50 | nAdc |
| Collector Cutoff Current (VCE = 30 Vdc, VEB(off) = | 3.0 Vdc) | ICEX | _ | 50 | nAdc |
| ON CHARACTERISTICS(1) | | • | | • | |
| DC Current Gain (I _C = 0.1 mAdc, V _{CE} = 1.0 Vdc) | MM3903 MM3904 | hFE | 20 40 | = | _ |
| (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) | MM3903 MM3904 | | 35 70 | = | |
| (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) | MM3903 MM3904 | | 50 100 | 150 300 | |
| (I _C = 50 mAdc, V _{CE} = 1.0 Vdc) | MM3903 MM3904 | | 30 60 | = | |
| (I _C = 100 mAdc, V _{CE} = 1.0 Vdc) | MM3903 MM3904 | | 10 15 | _ | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc) | | VCE(sat) | _ | 0.2 0.3 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc) | | V _{BE(sat)} | 0.65 | 0.85 0.95 | Vdc |

ns

MM3903, MM3904

Fail Time

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| | Characteristic | | Symbol | Min | Max | Unit |
|--|---|-----------------------|----------------|------------|------------|------|
| SMALL-SIGNAL CHA | RACTERISTICS | | | | | |
| Current-Gain — Band (IC = 10 mAdc, VC | width Product(1) E = 20 Vdc, f = 100 MHz) | MM3903 MM3904 | fτ | 250 300 | = | MHz |
| Output Capacitance (VCB = 5.0 Vdc, IE | = 0, f = 100 kHz) | | Copo | _ | 4.0 | pF |
| tnput Capacitance (VBE = 0.5 Vdc, IC | = 0, f = 100 kHz) | | Cibo | _ | 8.0 | pF |
| Smail-Signal Current (IC = 1.0 mAdc, Vo | Gain CE = 10 Vdc, f = 1.0 kHz) | MM3903 MM3904 | hfe | 50 100 | 200 400 | - |
| SWITCHING CHARAC | CTERISTICS | | | | | • |
| Delay Time | (VCC = 3.0 Vdc, VBE(off) = | 0.5 Vdc, | td | _ | 35 | ns |
| Rise Time | IC = 10 mAdc, IB1 = 1.0 m | Adc) | tr | _ | 35 | ns |
| Storage Time | (V _{CC} = 3.0 Vdc, I _C = 10 m. I _{B1} = I _{B2} = 1.0 mAdc) | Adc, MM3903 MM3904 | t _s | _ | 175 200 | ns |

tf

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MM3905 MM3906

CASE 27-02, STYLE 1 TO-52 (TO-206AC)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|-------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | VCBO | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | IC | 200 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 360 2.06 | mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +200 | *C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|-----|------|
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 490 | •c/w |

Refer to 2N3250 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|------------------|-------------|------------|--------------|------|
| OFF CHARACTERISTICS | | | | _ | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, Ig = 0) | | V(BR)CEO | 40 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | | V(BR)CBO | 40 | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | | Vdc |
| Base Cutoff Current (VCE = 30 Vdc, VBE = 3.0 Vdc) | | !BEV | _ | 50 | nAdc |
| Collector Cutoff Current (VCE = 30 Vdc, VBE = 3.0 Vdc) | | ICEV | | 50 | nAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain {IC = 0.1 mAdc, V _{CE} = 1.0 Vdc} | MM3905 MM3906 | hFE | 30 60 | = | _ |
| (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) | MM3905 MM3906 | | 40 80 | = | \ |
| (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) | MM3905 MM3906 | | 50 100 | 150 300 | |
| $(I_C = 50 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc})$ | MM3905 MM3906 | | 30 60 | = | |
| (IC = 100 mAdc, VCE = 1.0 Vdc) | MM3905 MM3906 | | 10 15 | | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc) | | VCE(sat) | | 0.25 0.4 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) (IC = 50 mAdc, Ig = 5.0 mAdc) | | VBE(sat) | 0.65 — | 0.85 0.95 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product(1) (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 100 MHz) | MM3905 MM3906 | fT | 200 250 | = | MHz |

MM3905, MM3906

| Characteristic | | Symbol | Min | Max | Unit | |
|---|---|----------------------|-------------------|------------------------|-----------------------|--------|
| Output Capacitance (VCB = 5.0 Vdc, IE | = 0, f = 100 kHz) | | C _{obo} | _ | 5.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC | = 0, f = 100 kHz) | ** | Cibo | _ | 10 | pF |
| Input Impedance (IC = 1.0 mAdc, Vo | CE = 10 Vdc, f = 1.0 kHz) | MM3905 MM3906 | h _{ie} | 0.5 2.0 | 8.0 12 | k ohms |
| Voltage Feedback Ra (IC = 1.0 mAdc, Vo | tio CE = 10 Vdc, f = 1.0 kHz) | MM3905 MM3906 | h _{re} | 0.1 X 10-4 1 X 10-4 | 5 X 10-4 10 X 10-4 | - |
| Small-Signal Current (IC = 1.0 mAdc, Vo | Gain CE = 10 Vdc, f = 1.0 kHz) | MM3905 MM3906 | . h _{fe} | 50 100 | 200 400 | _ |
| Output Admittance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | | MM3905 MM3906 | h _{oe} | 1.0 3.0 | 40 60 | μmhos |
| Noise Figure (IC = 100 µAdc, VCE = 5.0 Vdc, RS = 1.0 k ohm, f = 10 Hz to 15.7 kHz) | | MM3905 MM3906 | NF | _ | 5.0 4.0 | dB |
| SWITCHING CHARA | CTERISTICS | - | | | | |
| Delay Time | (VCC = 3.0 Vdc, VBE(off) = 0 | .5 Vdc, | td | _ | 35 | ns |
| Rise Time | IC = 10 mAdc, IB1 = 1.0 mA | | tr | _ | 35 | ns |
| Storage Time | (V _{CC} = 3.0 Vdc, I _C = 10 mAd | MM3905 dc, MM3906 | t _S | = | 200 225 | ns |

| Delay Time | (V _{CC} = 3.0 Vdc, V _{BE(off)} = 0.5 Vdc, I _C = 10 mAdc, I _{B1} = 1.0 mAdc) | | P | - | 35 | กร |
|--------------|--|----------------|----------------|-----|------------|----|
| Rise Time | | | tr | _ | 35 | ns |
| Storage Time | (VCC = 3.0 Vdc, IC = 10 mAdc, MM | M3905 M3906 | t _S | _ | 200 225 | ns |
| Fail Time | | M3905 M3906 | tf | 1 1 | 60 75 | ns |

⁽¹⁾ Pulse Test: Pulse Width = 300 μ s, Duty Cycle = 2.0%.

MM4000 thru MM4003

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| WANTED IN THE TOTAL | | | | | | |
|--|----------------------|-------------|-------------|-------------|-------------|----------------|
| Rating | Symbol | MM4000 | MM4001 | MM4002 | MM4003 | Unit |
| Collector-Emitter Voltage | VCEO | 100 | 150 | 200 | 250 | Vdc |
| Collector-Base Voltage | VCBO | 100 | 150 | 200 | 250 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | 4.0 | 4.0 | 4.0 | Vdc |
| Collector Current — Continuous | lc | 100 | 500 | 500 | 500 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.6 3.42 | 1.0 5.71 | 1.0 5.71 | 1.0 5.71 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 3.0 17.2 | 5.0 28.6 | 5.0 28.6 | 5.0 28.6 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | | | | °C |

Refer to 2N3494 for graphs for MM4000.*

| Characteristic | | Symbol | Min | Max | Unit |
|---|--------------------------------------|----------------------|--------------------------|-------------------|------|
| OFF CHARACTERISTICS | - | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | MM4000 MM4001 MM4002 MM4003 | V(BR)CEO | 100 150 200 250 | - | Vdc |
| Collector-Base Breakdown Voltage (I _E = 0, I _C = 100 μAdc) | MM4000 MM4001 MM4002 MM4003 | V(BR)CBO | 100 150 200 250 | _ _ _ _ | Vdc |
| Emitter-Base Breakdown Voltage (Ig = 100 μAdc, IC = 0) | | V _{(BR)EBO} | 4.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) (VCB = 75 Vdc, IE = 0) (VCB = 150 Vdc, IE = 0) | MM4000 MM4001 MM4002, MM4003 | ICBO | = | 1.0 1.0 5.0 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(1) (IC = 10 mAdc, VCE = 10 Vdc) | | hFE | 20 | _ | |
| Collector-Emitter Saturation Voltage(1) (IC = 10 mAdc, Ig = 1.0 mAdc) | MM4000, MM4001 MM4002, MM4003 | VCE(sat) | | 0.6 5.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Output Capacitance (VCB = 20 Vdc, I _E = 0, f = 100 kHz) | MM4000 MM4001 MM4002, MM4003 | C _{obo} | = | 6.0 10 20 | pF |

⁽¹⁾ Pulse Test: PW \leq 300 μ s, Duty Cycle \leq 2.0%.

^{*}Refer to 2N3634 for graphs for MM4001.

Refer to 2N4930 for graphs for MM4002 and MM4003.

| Rating | Symbol | MM4005 | MM4006 | MM4007 | Unit |
|--|-----------------------------------|-----------|-------------|----------------|---------------|
| Collector-Emitter Voltage | VCEO | 60 | 80 | 100 | Vđc |
| Collector-Base Voltage | VCBO | 60 | 80 | 100 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc | |
| Collector Current — Continuous | lc | 1.0 | | | Adc |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | | 1.0 5.71 | | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 7.0 40 | | Watts mW/°C | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | _ | -65 to +2 | 00 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|----------------------|-----|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 25 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 175 | °C/W |

⁽¹⁾ Raja is measured with the device soldered into a typical printed circuit board.

MM4005 thru MM4007

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

AMPLIFIER TRANSISTOR

PNP SILICON

Refer to 2N4033 for graphs.

| ELECTRICAL | CHADACTEDICTICS /T. | = 25°C unless otherwise noted.) | |
|---------------|---------------------|---------------------------------|----|
| PIPE: INC. AL | CHANACIPHISTICS (1) | = 75" integs otherwise noted i | ı. |

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|----------------------------|----------------------|-----------------|-----------|-------------------|------|
| OFF CHARACTERISTICS | | - | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, IB = 0) | MM4005 MM4006 MM4007 | V(BR)CEO | 60 80 100 | 111 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | MM4005 MM4006 MM4007 | V(BR)CBO | 60 80 100 | - | | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 μAdc, IC = 0) | | V _{(BR)EBO} | 5.0 | | _ | Vdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) (VCB = 60 Vdc, IE = 0) (VCB = 80 Vdc, IE = 0) | MM4005 MM4006 MM4007 | ІСВО | | = | 100 100 100 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | | IEBO | - | _ | 100 | nAdc |
| ON CHARACTERISTICS(2) | | | | | | |
| DC Current Gain (IC = 1.0 mAdc, V _{CE} = 1.0 Vdc) (IC = 150 mAdc, V _{CE} = 1.0 Vdc) | | hFE | 40 50 | 90 150 | | _ |
| Collector-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) | | VCE(sat) | _ | 0.1 | - | Vdc |
| Base-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) | | V _{BE(sat)} | _ | 0.7 | - | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product(2) (IC = 50 mAdc, VCE = 10 Vdc, f = 20 MHz) | | fτ | 50 | 250 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | | Cobo | _ | 10 | _ | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | | C _{ibo} | _ | 100 | _ | pF |

(2) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

MM4036 MM4037

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

SWITCHING TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage MM4036 MM4037 | VCEO | - 65 40 | Vdc |
| Collector-Base Voltage MM4036 MM4037 | V _{CBO} | .90 60 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Base Current | IB | 500 | mAdc |
| Collector Current — Continuous | lc | 1.0 | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.71 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 7.0 40 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | •€ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|----------------------|-----|------|
| Thermal Resistance, Junction to Case | ReJC | 25 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 175 | °C/W |

⁽¹⁾ Raja is measured with the device soldered into a typical printed circuit board.

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|--|----------------------|----------------------------------|----------------------------------|-----------------------------|--------------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, IB = 0) | MM4036 MM4037 | V(BR)CEO | 65 40 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 \(\mu\)Adc, IE = 0) (IC = 10 \(\mu\)Adc, IE = 0) | MM4036 MM4037 | V(BR)CBO | 90 60 | _ | = | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 μAdc, IC = 0) (IE = 1.0 μAdc, IC = 0) | MM4036 MM4037 | V(BR)EBO | 5.0 5.0 | _ | = | Vdc |
| Collector Cutoff Current(1) (VCE = 60 Vdc, VBE(off) = 1.5 Vdc) (VCE = 30 Vdc, VBE(off) = 1.5 Vdc, TC = 150°C) | MM4036 MM4036 | ICEV | = | = | 250 100 | nAdo µAdo |
| Collector Cutoff Current (VCB = 60 Vdc, IE = 0) | MM4036, MM4037 | СВО | 1 | _ | 250 | nAdo |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) (VBE = 5.0 Vdc, IC = 0) | MM4036 MM4037 | IEBO | - | = | 250 1.0 | μAdo |
| ON CHARACTERISTICS(2) | | | | , | , | |
| DC Current Gain (IC = 100 µAdc, VCE = 10 Vdc) (IC = 150 mAdc, VCE = 2.0 Vdc) (IC = 150 mAdc, VCE = 10 Vdc) (IC = 500 mAdc, VCE = 10 Vdc) (IC = 1.0 mAdc, VCE = 10 Vdc) (IC = 150 mAdc, VCE = 10 Vdc) | MM4036 MM4036 MM4036 MM4036 MM4037 MM4037 | hFE | 20 20 40 20 15 50 | 50 60 90 40 50 75 | 200 140 — — 250 | <u>-</u> |
| Collector-Emitter Saturation Voltage (IC = 150 mAdc, Ig = 15 mAdc) | MM4036 MM4037 | VCE(sat) | _ | 0.3 0.3 | 0.65 1.4 | Vdc |
| Base-Emitter Saturation Voltage (IC = 150 mAdc, Ig = 15 mAdc) | | V _{BE(sat)} | _ | 1.0 | 1.4 | Vdc |

MM4036, MM4037

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

| | Characteristic | Symbol | Min | Тур | Max | Unit |
|---|--|-----------------|-----|----------|-----|------|
| SMALL-SIGNAL CH | ARACTERISTICS | | | | | |
| Current-Gain — Ban- (IC = 50 mAdc, Vo | dwidth Product(2) CE = 10 Vdc, f = 20 MHz) | fT | 60 | 100 | _ | MHz |
| Input Capacitance (VBE = 0.5 Vdc, Ic | c = 0, f = 1.0 MHz) MM4036, MM4037 | Cibo | _ | 60 | _ | pF |
| Collector-Base Capac (VCB = 10 Vdc, IE | citance = 0, f = 1.0 MHz) MM4036 MM4037 | C _{cb} | _ | 20 20 | 30 | pF |
| SWITCHING CHARA | CTERISTICS | | | | | |
| Turn-On Time | (V _{CC} = 30 Vdc, I _C = 150 mAdc, I _{B1} = 15 mAdc) | ton | . — | 40 | 75 | ns |
| Turn-Off Time | (V _{CC} = 6.0 Vdc, I _C = 150 mAdc, I _{B1} = I _{B2} = 15 mAdc) | toff | _ | 110 | 175 | ns |

⁽²⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MM4052

CASE 26-03, STYLE 1 TO-46 (TO-206AB)

CHOPPER AND SWITCHING TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 30 | Vdc |
| Emitter-Collector Voltage | VECO | 30 | Vdc |
| Collector-Base Voltage | V _{CBO} | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 30 | Vdc |
| Collector Current — Continuous | lc | 500 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.5 2.86 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.75 10 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

Refer to 2N2944A for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|-----------------|-------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, Ig = 0) | V(BR)CEO | 30 | _ | Vdc |
| Emitter-Collector Breakdown Voltage(1) (IE = 10 mAdc, IB = 0) | V(BR)ECO | 30 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 30 | _ | Vdc |
| Emitter-Base Breakdown Voltage(1) (IE = 100 µAdc, IC = 0) | V(BR)EBO | 30 | _ | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) | IСВО | - | 0.5 | пАдс |
| Emitter Cutoff Current (VEB = 15 Vdc, I _C = 0) | IEBO | _ | 0.5 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain(1) (I _C = 10 mAdc, V_{CE} = 1.0 Vdc) (I _C = 150 mAdc, V_{CE} = 1.0 Vdc) (I _C = 150 mAdc, V_{CE} = 1.0 Vdc) (Inverted) | hfE | 20 15 3.0 | _ _ _ | _ |
| Offset Voltage (I _B = 1.0 mAdc, I _E = 0) | VEC(ofs) | - | 2.0 | mVdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Output Capacitance (VCB = 10 Vdc, IE = 0, 100 kHz ≤ f ≤ 1.0 MHz) | C _{obo} | _ | 10 | pF |
| Input Capacitance (VEB = 10 Vdc, I _C = 0, 100 kHz ≤ f ≤ 1.0 MHz) | C _{ibo} | _ | 5.0 | pF |
| Small-Signal Current Gain (IC = 10 mAdc, VCE = 1.0 Vdc, f = 1.0 kHz) (IC = 10 mAdc, VCE = 1.0 Vdc, f = 4.0 MHz) | h _{fe} | 20 3.0 | - | _ |
| "ON" Series Resistance (IB = 10 mAdc, f = 1.0 kHz) | rec | _ | 2.0 | Ohms |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 20%.

| INDUMONI IDALINGO | | | | |
|---|-----------------------------------|--------------|--------|----------------|
| Rating | Symbol | MM4208 | MM4209 | Unit |
| Collector-Emitter Voltage | VCEO | 12 | 15 | Vdc |
| Collector-Base Voltage | V _{CBO} | 12 | 15 | Vdc |
| Emitter-Base Voltage | VEBO | 4.5 | | Vdc |
| Collector Current — Continuous | lc | 200 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.36 2.06 | | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 6.86 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | °C |

MM4208 MM4209

CASE 22-03, STYLE 1 TO-18 (TO-206AA)

SWITCHING TRANSISTOR

PNP SILICON

Refer to MM4257 for graphs.

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|--|----------|-------------|-------------|-------------------------------------|--------------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 3.0 mAdc, IB = 0) | MM4208 MM4209 | V(BR)CEO | 12 15 | _ | = | Vdc |
| Collector-Emitter Breakdown Voltage (I _C = 100 μAdc, V _{BE} = 0) | MM4208 MM4209 | V(BR)CES | 12 15 | = | = | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0) | MM4208 MM4209 | V(BR)CBO | 12 15 | = | = | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 μ Adc, IC = 0) | | V(BR)EBO | 4.5 | <u> </u> | _ | Vdc |
| Collector Cutoff Current (VCE = 6.0 Vdc, VBE = 0) (VCE = 8.0 Vdc, VBE = 0) (VCE = 8.0 Vdc, VBE = 0, TA = 125°C) (VCE = 8.0 Vdc, VBE = 0, TA = 125°C) | MM4208 MM4209 MM4208 MM4209 | ICES | _ _ _ | _ _ _ | 10 10 5.0 5.0 | nAdc μAdc |
| Base Current (VCE = 6.0 Vdc, VBE = 0) (VCE = 8.0 Vdc, VBE = 0) ON CHARACTERISTICS | MM4208 MM4209 | IB | = | = | 1.0 1.0 | nAdc |
| | | | | | | |
| DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 0.5 Vdc) | MM4208 MM4209 | hFE | 15 35 | _ | _ | - |
| (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) | MM4208 MM4209 | | 30 40 | _ | 100 120 | |
| $(I_C = 10 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc}, T_A = -55^{\circ}\text{C})$ | MM4208 MM4209 | | 12 20 | _ | _ | |
| (IC = 50 mAdc, VCE = 1.0 Vdc)(1) | MM4208 MM4209 | | 30 30 | _ | - | |
| Collector-Emitter Saturation Voltage (IC = 1.0 mAdc, Ig = 0.1 mAdc) (IC = 10 mAdc, Ig = 1.0 mAdc) (IC = 50 mAdc, Ig = 5.0 mAdc)(1) (IC = 1.0 mA, Ig = 0.1 mA) (IC = 10 mA, Ig = 1.0 mA) | MM4208 MM4208 MM4208, MM4209 MM4209 MM4209 | VCE(sat) | 1111 | 11111 | 0.13 0.15 0.6 0.15 0.18 | Vdc |

MM4208, MM4209

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|------------------|------------|--------------|-------------------|------|
| Base-Emitter Saturation Voltage (IC = 1.0 mAdc, Ig = 0.1 mAdc) (IC = 10 mAdc, Ig = 1.0 mAdc) (IC = 50 mAdc, Ig = 5.0 mAdc)(1) | VBE(sat) | 0.75 | 111 | 0.8 .95 1.5 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | 1 | | · |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 10 Vdc, f = 100 MHz) MM4208 | fT | 850 700 | 1300 1200 | - | MHz |
| Output Capacitance (V _{CB} = 5.0 Vdc, I _E = 0, f = 140 kHz) | Cobo | | _ | 3.0 | pF |
| Input Capacitance (V _{BE} = 0.5 Vdc, I _C = 0, f = 140 kHz) | C _{ibo} | _ | _ | 3.5 | pF |
| SWITCHING CHARACTERISTICS | | | | | |
| Turn-On Time | ton | _ | | 15 | ns |
| Turn-Off Time | toff | _ | _ | 25 | ns |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 1.0%.

MM4257 MM4258

CASE 22, STYLE 1 TO-18 (TO-206AA) SWITCHING TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | MM4257 | MM4258 | Unit |
|---|-----------------------------------|-------------|--------|----------------|
| Collector-Emitter Voltage | VCEO | 6.0 | 12 | Vdc |
| Collector-Base Voltage | VCBO | 6.0 | 12 | Vdc |
| Emitter-Base Voltage | VEBO | 4.5 | | Vdc |
| Collector Current — Continuous | lc | 200 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 360 2.06 | | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 6.86 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | °C |

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|------------------|------------------|----------------|----------|---------------|------|
| OFF CHARACTERISTICS | - | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 100 μAdc, V _{BE} = 0) | MM4257 MM4258 | V(BR)CES | 6.0 12 | = | = | Vdc |
| Collector-Emitter Sustaining Voltage(1) (IC = 3.0 mAdc, IB = 0) | MM4257 MM4258 | VCEO(sus) | 6.0 12 | = | <u>-</u> | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | MM4257 MM4258 | V(BR)CBO | 6.0 12 | = | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 4.5 | _ | _ | Vdc |
| Collector Cutoff Current (VCE = 6.0 Vdc, VBE = 0) (VCE = 3.0 Vdc, VBE = 0, TA = +65°C) | | ICES | | =_ | 0.01 5.0 | μAdc |
| ON CHARACTERISTICS(1) | | | | | | |
| DC Current Gain (IC = 1.0 mAdc, VCE = 0.5 Vdc) (IC = 10 mAdc, VCE = 0.3 Vdc) (IC = 50 mAdc, VCE = 1.0 Vdc) | | PFE | 15 30 30 | = | _ 120 _ | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc) | | VCE(sat) | 11 | = | 0.15 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc) | | VBE(sat) | 0.75 | <u> </u> | 0.95 1.5 | Vdc |
| SMALL SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product(2) (I _C = 10 mAdc, V _{CE} = 5.0 Vdc, f = 100 MHz) (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | MM4257 MM4258 | ft | 500 700 | _ | _ | MHz |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 100 kHz) | | C _{ibo} | _ | _ | 3.5 | рF |
| Collector-Base Capacitance (VCB = 5.0 Vdc, IE = 0, f = 100 kHz) | | C _{cb} | _ | | 3.0 | pF |

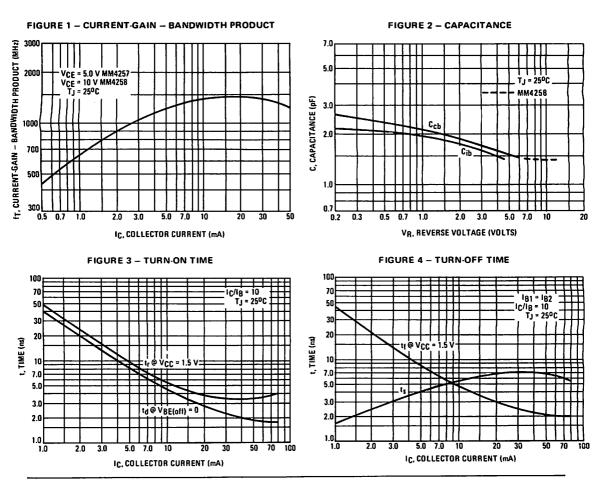
MM4257, MM4258

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| | Characteristic | | Symbol | Min | Тур | Max | Unit |
|------------------------------------|--|---|----------------|-----|------------|----------|------|
| SWITCHING CHARA | CTERISTICS | | | • | | | |
| Turn-On Time | | | ton | _ | 10 | 15 | ns |
| Delay Time | | (V _{CC} = 1.5 Vdc, V _{BE} = 0, I _C = 10 mAdc, I _{B1} = 1.0 mAdc) | | _ | 5.0 | 10 | ns |
| Rise Time | 16 - 10 made, 181 - 1.0 m | | | | 5.0 | 15 | ns |
| Turn-Off Time | (V _{CC} = 1.5 Vdc, | MM4257 MM4258 | toff | = | 12 16 | 15 20 | ns |
| Storage Time | I _C = 10 mAdc, I _{B1} = I _{B2} = 1.0 mAdc) | MM4257 MM4258 | t _S | = | 6.0 8.0 | 15 20 | ns |
| Fall Time | | MM4257 MM4258 | tf | - | 6.0 8.0 | 10 10 | ns |
| Storage Time (IC ~ 10 mAdc, IB- | ≈ 10 mAdc, I _{B2} ≈ 10 mAdc) | MM4257 MM4258 | t _S | - | _ | 15 20 | ns |

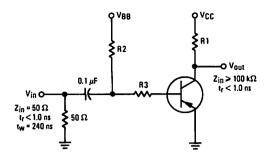
⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

TYPICAL TRANSIENT CHARACTERISTICS



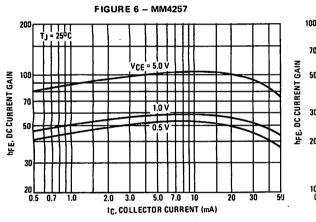
⁽²⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.

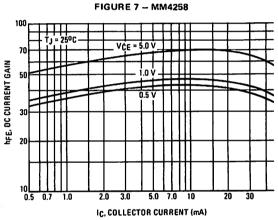
FIGURE 5 - SWITCHING TIME TEST CIRCUIT

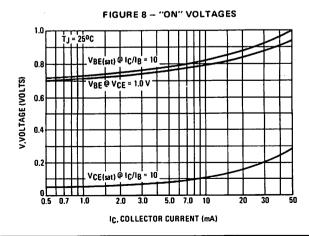


| | V _{in} Volts | V _{BB} Volts | V _{CC} Volts | | R2 Ohms | | IC mA | IB1 mA | IB2 mA |
|------|--------------------------|--------------------------|--------------------------|-----|------------|-----|----------|-----------|-----------|
| ton | - 5.8 | GND | -1.5 | 130 | 2.2 k | 5 k | 10 | 1.0 | - |
| toff | +9.8 | -8.0 | -1.5 | 130 | 2.2 k | 5 k | 10 | 1.0 | 1.0 |
| ts | +9.0 | -10 | - 3.0 | 270 | 510 | 390 | 10 | 10 | 10 |

DC CURRENT GAIN







MOTOROLA SEMICONDUCTORS

MM5005 MM5006 MM5007

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

AUDIO TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| MAXIMON NATINGS | | | | | | | |
|--|----------------------|-------------|--------|----------------|------|--|-----|
| Rating | Symbol | MM5005 | MM5006 | MM5007 | Unit | | |
| Collector-Emitter Voltage | VCEO | 60 | 80 | 100 | Vdc | | |
| Collector-Base Voltage | VCBO | 80 | 100 | 120 | Vdc | | |
| Emitter-Base Voltage | VEBO | 5.0 Vo | | | Vdc | | |
| Collector Current — Continuous | lc | 2.0 | | | 2.0 | | Adc |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | | | Watts mW/°C | | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 8.0 45.7 | | Watts mW/°C | | | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | | | ပ္ | | |

| Characteristic | | Symbol | Min | Max | Unit |
|---|---|------------------|----------------------|-------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | MM5005 MM5006 MM5007 | V(BR)CEO | 60 80 100 | = | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | MM5005 MM5006 MM5007 | V(BR)CBO | 80 100 120 | = | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 60 Vdc, lg = 0) (VCB = 80 Vdc, lg = 0) (VCB = 100 Vdc, lg = 0) | MM5005 MM5006 MM5007 | ІСВО | = | 200 200 200 | nAdc |
| Emitter Cutoff Current (VEB = 4.0 Vdc, I _C = 0) | | IEBO | _ | 100 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 1.0 mAdc, V _{CE} = 1.0 Vdc) (IC = 150 mAdc, V _{CE} = 2.5 Vdc) (IC = 200 mAdc, V _{CE} = 2.5 Vdc) (IC = 250 mAdc, V _{CE} = 2.5 Vdc) | All Types MM5005 MM5006 MM5007 | hFE | 40 50 50 50 | | _ |
| Collector-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) | | VCE(sat) | _ | 0.5 | Vdc |
| Base-Emitter On Voltage (IC = 150 mAdc, VCE = 2.5 Vdc) | | VBE(on) | 0.65 | 0.8 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | • |
| Current-Gain — Bandwidth Product(1) (IC = 50 mAdc, VCE = 10 Vdc, f = 20 MHz) | | fτ | 30 | _ | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 100 kHz) | | C _{obo} | _ | 20 | pF |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| Rating | Symbol | Value | Unit |
|---|----------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 50 | Vdc |
| Collector-Emitter Voltage | VCES | 60 | Vdc |
| Collector-Base Voltage | VCBO | 75 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | Vdc |
| Collector Current — Continuous | lс | 2.0 | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.71 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 4.0 22.8 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | °C |

THERMAL CHARACTERISTICS

| *************************************** | | | |
|---|----------------------|-----|------|
| Characteristic | Symbol | Max | Unit |
| Thermal Resistance, Junction to Case | ReJC | 44 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 175 | •c/w |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

MM5262

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to 2N3724 for graphs.

| FI FCTRICAL | CHARACTERISTICS (TA = | 25°C unless otherwise noted.) |
|-------------|-----------------------|---|

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|------------------|----------------|-----------------|----------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, Ig = 0) | V(BR)CEO | 50 | _ | _ | Vdc |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, V _{BE} = 0) | V(BR)CES | 60 | | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 75 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | V(BR)EBO | 5.0 | | - | Vdc |
| Collector Cutoff Current (VCB = 75 Vdc, IE = 0) | ІСВО | 1 | _ | 100 | μAdc |
| Collector Cutoff Current (VCE = 60 Vdc, VBE = 0) | ICES | _ | _ | 10 | μAdc |
| Emitter Cutoff Current (VBE = 5.0 Vdc, IC = 0) | IEBO | _ | _ | 100 | μAdc |
| ON CHARACTERISTICS(2) | | | | | |
| DC Current Gain (IC = 100 mAdc, VCE = 1.0 Vdc) (IC = 500 mAdc, VCE = 1.0 Vdc) (IC = 1.0 Adc, VCE = 1.0 Vdc) | hṛE | 35 40 25 | 100 65 35 | <u>-</u> | _ |
| Collector-Emitter Saturation Voltage (IC = 1.0 Adc, IB = 100 mAdc) | VCE(sat) | | 0.29 | 0.8 | Vdc |
| Base-Emitter Saturation Voltage (IC = 1.0 Adc, IB = 100 mAdc) | VBE(sat) | _ | 0.94 | 1.4 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 50 mAde, VCE = 10 Vde, f = 100 MHz) | fτ | _ | 350 | | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | C _{obo} | _ | 7.3 | _ | pF |
| Input Capacitance (VgE = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | C _{ibo} | _ | 72 | - | pF |
| SWITCHING CHARACTERISTICS | | | | | |
| Turn-On Time | ton | | 16 | 30 | ns |
| Turn-Off Time | toff | _ | 28 | 60 | ns |

(2) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

MM5415 MM5416

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | MM5415 | MM5416 | Unit |
|---|------------------|-------------|--------|----------------|
| Collector-Emitter Voltage | VCEO | 200 | 300 | Vdc |
| Collector-Base Voltage | V _{CBO} | 200 | 350 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | 7.0 | Vdc |
| Base Current | ΙB | 0.5 | | Adc |
| Collector Current — Continuous | lc | 1.0 | | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 6.7 | | Watt W/°C |
| Total Power Dissipation @ T _C = 50°C Linear Derating Factor | PD | 10 0.057 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, Tstg | -65 to +200 | | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|------|------|
| Thermal Resistance, Junction to Case | ReJC | 17.5 | •c/w |
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 150 | °C⁄W |

Refer to 2N5415 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|------------------|-----------------------|------------|------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Sustaining Voltage (IC = 10 mA, IB = 0) | MM5415 MM5416 | V _{CEO(sus)} | 200 300 | = | Vdc |
| Collector Cutoff Current (VCE = 150 Vdc, Ig = 0) | MM5415, MM5416 | ICEO | _ | 50 | μAdc |
| Collector Cutoff Current (VCE = 175 Vdc, I _E = 0) (VCE = 280 Vdc, I _E = 0) | MM5415 MM5416 | ICBO | _ | 50 50 | μAdc μAdc |
| Emitter Cutoff Current (VBE = 4.0 Vdc, I _C = 0) (VBE = 7.0 Vdc, I _C = 0) | MM5415 MM5416 | IEBO | <u>-</u> | 20 20 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 50 mAdc, V _{CE} = 10 Vdc) | MM5415 MM5416 | hFE | 30 30 | 150 120 | _ |
| Collector-Emitter Saturation Voltage (IC = 50 mAdc, IB = 5.0 mAdc) | MM5415, MM5416 | V _{CE(sat)} | _ | 2.5 | Vdc |
| Base-Emitter On Voltage (IC = 50 mAdc, VCE = 10 V) | MM5415, MM5416 | V _{BE(on)} | _ | 1.5 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 10 Vdc, f = 5.0 MHz) | | fT | 15 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, f = 1.0 MHz) | | Cobo | _ | 25 | pF |
| Current Gain — High Frequency (IC = 5.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | | h _{fe} | 25 | _ | _ |
| Real Pert of Input Impedance (IC = 5.0 mAdc, VCE = 10 Vdc, f = 1.0 MHz) | | Re(h _{ie}) | _ | 300 | Ohms |

| Rating | Symbol | Value | Unit |
|---|----------------------|--------------|---------------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 50 | Vdc |
| Emitter-Base Voltage | VEBO | 12 | Vdc |
| Collector Current — Continuous | lc | 300 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 375 2.14 | mW W/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.25 7.15 | Watts W/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | °C |

MM6427

CASE 22-03, STYLE 1 TO-18 (TO-206AA)

DARLINGTON TRANSISTOR

NPN SILICON

THERMAL CHARACTERISTICS

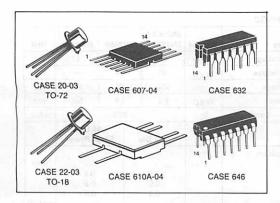
| Characteristic | Symbol | Max | Unit |
|---|--------|-----|------|
| Thermal Resistance, Junction to Case | R&C | 140 | °C/W |
| Thermal Resistance, Junction to Ambient | RAJA | 467 | •cw |

| Characteristic | Symbol | Min | Max | Unit |
|--|------------------|----------------|-----|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 40 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 µAdc, I _E = 0) | V(BR)CBO | 50 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | V(BR)EBO | 12 | _ | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0) | ІСВО | _ | 100 | nAdc |
| Emitter Cutoff Current (VBE = 10 Vdc, I _C = 0) | IEBO | | 100 | nAdc |
| ON CHARACTERISTICS(1) | | | | |
| DC Current Gain (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) (I _C = 100 mAdc, V _{CE} = 5.0 Vdc) | ptE | 5000 10,000 | = | _ |
| Collector-Emitter Saturation Voltage (IC = 100 mAdc, Ig = 0.1 mAdc) | VCE(sat) | _ | 1.5 | Vdc |
| Base-Emitter On Voltage (IC = 100 mAdc, VCE = 5.0 Vdc) | VBE(on) | _ | 2.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Output Capacitance (VCB = 10 Vdc, $I_E = 0$, $f = 100$ kHz) | C _{obo} | _ | 8.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = 0, f = 100 kHz) | C _{ibo} | _ | 15 | pF |
| Small-Signal Current Gain(1) (I _C = 10 mAdc, V _{CE} = 5.0 Vdc, f = 100 MHz) | hfe | 1.25 | _ | |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

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Transfer was a subsection



Motorola's multiple (Duals and Quads) transistors have been implemented with discrete transistor chips that have proven to be the most popular for all-around performance at low cost.

Packaging options include plastic and ceramic DIP's, ceramic flat pak, and various metal-can outlines.

Multiple Transistors

5-1

2N2060,A 2N2223,A 2N2480,A

2N2060 JAN, JTX, JTXV AVAILABLE CASE 654-07, STYLE 1

DUAL AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MD2218 for graphs.

MAXIMUM RATINGS

| MAXIMUM RATINGS | | | | | | | | | | |
|---|------------------|---|--------|-------|---|----------------|--------|-----|---------|------|
| Rating | Symbol | 2N2060,A 2N2223,A | 2N2480 | | 2N2480 | | 2N2480 | | 2N2480A | Unit |
| Collector-Emitter Voltage | VCEO | 60 | 40 | | 40 | | 40 | Vdc | | |
| Collector-Emitter Voltage | VCER | 80 | | _ | - | Vđc | | | | |
| Collector-Base Voltage | V _{CBO} | 100 | | 75 | 80 | Vdc | | | | |
| Emitter-Base Voltage | VEBO | 7.0 | E | 5.0 | 5.0 | Vdc | | | | |
| Collector Current — Continuous | lc | | 5 | 00 | | mAdc | | | | |
| | | All Die One Die Equal Power | | | | | | | | |
| Total Device Dissipation @ T _A = 25°C 2N2080,A 2N2223,A 2N2480,A Derate above 25°C 2N2080,A 2N2223,A 2N2480,A | PD | 0.5 0.5 0.3 2.86 2.86 1.72 | | | 0.6 0.6 0.6 3.43 3.43 3.43 | mW/°C | | | | |
| Total Device Dissipation @ T _C = 25°C 2N2080,A 2N2223,A 2N2480,A Derate above 25°C 2N2080,A 2N2223,A 2N2223,A 2N2480,A | PD | 1.5 1.6 1.0 8.6 9.1 5.7 | | | 3.0 3.0 2.0 17.2 11.4 11.4 | Watts mW/°C | | | | |
| Operating and Storage Junction Temperature Range | Tj, Tstg | | - 65 t | o +20 | 00 | °C | | | | |

| Characteristic | | Symbol | Min | Max | Unit |
|---|---|-----------------------|-----------------|-----------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 100 mAdc, RBE ≤ 10 ohms) | 2N2060, 2N2060A, 2N2223, 2N2223A | VCER(sus) | 80 | _ | Vdc |
| Collector-Emitter Sustaining Voltage(1) (I _C = 20 mAdc, I _B = 0) | 2N2480 2N2480A | V _{CEO(sus)} | 40 40 | _ | Vdc |
| $(I_C = 30 \text{ mAdc}, I_B = 0)$ | 2N2060, 2N2060A, 2N2223, 2N2223A | | 60 | = | |
| Collector-Base Breakdown Voltage (IC = 100 μAdc, IE = 0) | 2N2060, 2N2060A, 2N2223, 2N2223A 2N2480* 2N2480A* | V(BR)CBO | 100 75 80 | | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 µAdc, IC = 0) | 2N2060, 2N2060A, 2N2223, 2N2223A 2N2480, 2N2480A | V(BR)EBO | 7.0 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, I _E = 0, T _A = 150°C) | 2N2480, 2N2480A | Ісво | _ | 15 | μAdc |
| (VCB = 60 Vdc, IE = 0) | 2N2480 2N2480A | | = | 0.050 0.020 | |
| (VCB = 80 Vdc, IE = 0) | 2N2060, 2N2060A 2N2223, 2N2223A | | = | 0.002 0.010 | |
| (V _{CB} = 80 Vdc, I _E = 0, T _A = 150°C) | 2N2060, 2N2060A 2N2223, 2N2223A | | - | 10 15 | |
| Emitter Cutoff Current (VBE = 5.0 Vdc, IC = 0) | 2N2060, 2N2060A 2N2223, 2N2223A 2N2480 2N2480A | [†] EBO | = | 2.0 10 50 20 | nAdc |

2N2060,A

| Charact | eristic | Symbol | Min | Max | Unit |
|---|--|----------------------|----------------------|-------------------|--------|
| ON CHARACTERISTICS | | | • | • | • |
| DC Current Gain (IC = 10 μAdc, VCE = 5.0 Vdc) | 2N2060, 2N2060A 2N2223, 2N2223A | hFE | 25 15 | 75 | _ |
| (t _C = 100 μAdc, V _{CE} = 5.0 Vdc) | 2N2060, 2N2060A 2N2223, 2N2223A 2N2480 | | 30 25 20 | 90 150 — | |
| (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc) | 2N2480A 2N2060, 2N2060A 2N2480 2N2480A | | 35 40 30 50 | 120 350 200 | |
| (IC = 10 mAdc, VCE = 5.0 Vdc) | 2N2060, 2N2060A 2N2223, 2N2223A | | 50 50 | 150 200 | |
| Collector-Emitter Saturation Voltage (IC = 50 mAdc, IB = 5.0 mAdc) | 2N2060A 2N2060, 2N2223, 2N2223A, 2N2480A 2N2480 | VCE(set) | 111 | 0.6 1.2 1.3 | Vdc |
| Bese-Emitter Saturation Voltage (IC = 50 mAdc, IB = 5.0 mAdc) | 2N2060, 2N2060A, 2N2223, 2N2223A, 2N2480A 2N2480 | V _{BE(sat)} | = | 0.9 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | · | | | 1 |
| Current-Gain — Bandwidth Product (I _C = 50 mAdc, V _{CE} = 10 Vdc, f = 20 MHz) | 2N2223, 2N2223A 2N2480, 2N2480A 2N2060, 2N2060A | fŢ | 50 60 | = | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | 2N2060, 2N2060A, 2N2223, 2N2223A 2N2480A 2N2480 | C _{obo} | | 15 18 20 | pF |
| Input Capacitance (Vgg = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | 2N2060, 2N2060A, 2N2223, 2N2223A, 2N2480A | Cibo | _ | 85 | ρF |
| Input Impedance (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | 2N2060, 2N2060A 2N2480A | h _{io} | 1000 1000 | 4000 5000 | ohms |
| Input Impedence (I _C = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) | 2N2060, 2N2060A, 2N2223, 2N2223A 2N2480A | hib | 20 20 | 30 35 | ohms |
| Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) | 2N2223, 2N2223A | h _{rb} | _ | 3.0 | X 10-4 |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | 2N2060, 2N2060A 2N2223, 2N2223A 2N2480A | h _{fe} | 50 40 50 | 150 200 300 | _ |
| Output Admittance (IC = 1.0 mAde, VCE = 5.0 Vdc, f = 1.0 kHz) | 2N2060, 2N2060A, 2N2480A | h _{Qe} | - | 16 | μmhos |
| Output Admittance (IC = 1.0 mAdc, VCB = 5.0 Vdc, f = 1.0 kHz) | 2N2223, 2N2223A | h _{ob} | _ | 0.5 | μmhos |
| Noise Figure (I _C = 0.3 mAdc, V _{CE} = 10 Vdc, R _S = 510 Ω, f = 1.0 kHz, BW = 1.0 Hz) (I _C = 0.3 mAdc, V _{CE} = 10 Vdc, | 2N2480, 2N2480A | NF | _ | 8.0 | dB |

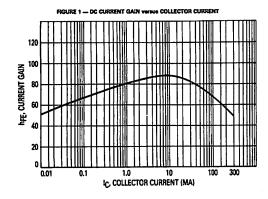
2N2060,A

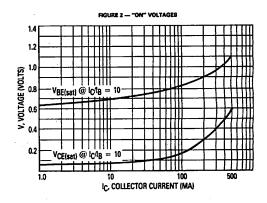
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|---|---|--|--------------|------------------------|----------|
| $R_S = 510 \Omega$, f = 1.0 kHz, $BW = 200 Hz$) (I _C = 0.3 mAdc, $V_{CE} = 10 \text{ Vdc}$, | 2N2060, 2N2060A | | _ | 8.0 | |
| $R_S = 1.0 \text{ k}\Omega$, f = 1.0 kHz, BW = 15.7 kHz)(2) | | | _ | 8.0 | |
| MATCHING CHARACTERISTICS | | | | | |
| DC Current Gain Ratio(3) | | hFE1/hFE2 | | | – |
| (I _C = 100 μAdc, V _{CE} = 5.0 Vdc) | 2N2060, 2N2060A, 2N2223A 2N2223, 2N2480, 2N2480A | | 0.9 0.8 | 1.0 1.0 | |
| (I _C = 1.0 mAdc, $V_{CE} = 5.0 \text{ Vdc}$) | 2N2060, 2N2080A 2N2480, 2N2480 | | 0.9 0.8 | 1.0 1.0 | |
| Base-Emitter Voltage Differential | | VBE1-VBE2 | | | mVdc |
| (I _C = 100 μAdc, V _{CE} = 5.0 Vdc) | 2N2060A 2N2060, 2N2223A, 2N2480A 2N2480 2N2223 | | . = | 3.0 5.0 10 15 | |
| (I _C = 1.0 mAdc, V_{CE} = 5.0 Vdc) | 2N2060, 2N2060A, 2N2480A 2N2480 | | _ | 5.0 .10 | |
| Base-Emitter Voltage Differential Change (IC = 100 μAdc, VCE = 5.0 Vdc, | Due to Temperature | Δ(V _{BE1} -V _{BE2}) ΔΤ | | | μV/°C |
| $T_A = -55^{\circ}C \text{ to } + 125^{\circ}C)$ | 2N2060A 2N2060 2N2223, 2N2223A | | - | 5.0 10 25 | |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

2N2480, 2N2480A





⁽²⁾ Amplifier: 3.0 Db points at 25 Hz and 10 kHz with a roll-off of 6.9 dB per octave.

⁽³⁾ The lowest hee reading is taken as hee1 for this ratio.

| HE-CHITCH TEXTINGS | | | | |
|---|-----------------------------------|-------------|--------------|-------------|
| Rating | Symbol | 2N2453 | 2N2453A | Unit |
| Collector-Emitter Voltage | VCEO | 30 | 50 | Vdc |
| Collector-Base Voltage | VCBO | 60 | 80 | Vdc |
| Emitter-Base Voltage | VEBO | 7.0 | | Vdc |
| Collector Current — Continuous | . lc | 50 | | mAdc |
| | | One Die | Both Die | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 200 1.14 | 300 1.71 | mW mW/℃ |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 600 3.43 | 1200 6.86 | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | ្ |

2N2453,A

CASE 654-07, STYLE 1

DUAL

AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N2920 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|-------------------|----------------------|-----------------------|---------------|-------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Sustaining Voltage(1) (I _C = 10 mAdc, I _B = 0) | 2N2453 2N2453A | VCEO(sus) | 30 50 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 µAdc, I _E = 0) | 2N2453 2N2453A | V(BR)CBO | 60 80 | = | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 0.1 μAdc, I _C = 0) | | V(BR)EBO | 7.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) (VCB = 50 Vdc, IE = 0, TA = 150°C) | | СВО | - | 0.005 10 | μAdc |
| Emitter Cutoff Current (VBE = 5.0 Vdc, IC = 0) | | †EBO | _ | 0.002 | μAdc |
| ON CHARACTERISTICS | _ | | | | |
| DC Current Gain (IC = 10 µAdc, VCE = 5.0 Vdc) (IC = 10 µAdc, VCE = 5.0 Vdc, TA = -55°C) (IC = 1.0 mAdc, VCE = 5.0 Vdc) (IC = 1.0 mAdc, VCE = 5.0 Vdc, TA = -55°C) | | hFE | 80 40 150 75 | — — 600 | _ |
| Collector-Emitter Saturation Voltage (IC = 5.0 mAdc, IB = 0.5 mAdc) | | VCE(sat) | _ | 1.0 | Vdc |
| Base-Emitter Saturation Voltage (IC = 5.0 mAdc, IB = 0.5 mAdc) | | V _{BE(sat)} | - | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | _ | | |
| Current-Gain — Bandwidth Product (IC = 5.0 mAdc, VCE = 10 Vdc, f = 30 MHz) | | ÍΤ | 60 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 140 kHz) | | C _{obo} | _ | 8.0 | ρF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 140 kHz) | | C _{ibo} | _ | 10 | pF |
| Input Impedance (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | | h _{ie} | 5.0 | _ | kohms |
| Input impedance (IC = 1.0 mAdc, VCB = 5.0 Vdc, f = 1.0 kHz) | | hib | 20 | 30 | Ohms |

2N2453,A

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|---|-----------------|-----|-----|--------|
| Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 kHz) | h _{re} | | 6.0 | X 10-4 |
| Voltage Feedback Ratio | hrb | - | | X 10-4 |
| (IC = 1.0 mAde, VCB = 5.0 Vdc, f = 1.0 kHz) | h. | - | 5.0 | ļ |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | h _{fe} | 150 | 600 | |
| Output Admittance (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 kHz) | h _{oe} | 5.0 | 30 | μmhos |
| Output Admittence (IC = 1.0 mAdc, VCB = 5.0 Vdc, f = 1.0 kHz) | h _{ob} | _ | 0.2 | μmho |
| Noise Figure (I _C = 10 μ Adc, V _{CE} = 5.0 Vdc, R _S = 10 k Ω , f = 1.0 kHz) | NF | _ | 7.0 | qB |

MATCHING CHARACTERISTICS

| DC Current Gain Ratio(2) | hFE1/hFE2 | | | _ |
|---|--|------|-----|-------|
| $(I_C = 100 \mu Adc, V_{CE} = 5.0 Vdc)$ 2N2453A | 1 1 | 0.90 | 1.0 | |
| $(I_C = 1.0 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$ | 1 | 0.90 | 1.0 | |
| $(I_C = 1.0 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc}, T_A = -55^{\circ}\text{C to} + 125^{\circ}\text{C})$ | | 0.85 | 1.0 | |
| Base-Emitter Voltage Differential | VBE1-VBE2 | | | mVdc |
| $(I_C = 10 \mu\text{Adc}, V_{CE} = 5.0 \text{Vdc})$ | | - | 3.0 | |
| (IC = 1.0 mAdc, VCE = 5.0 Vdc) | | _ | 5.0 | |
| Base-Emitter Voltage Differential Gradient | Δ(V _{BE1} -V _{BE2}) | | | μV/°C |
| $(I_C = 10 \mu\text{Adc}, V_{CE} = 5.0 \text{Vdc}, T_A = -55^{\circ}\text{C to} + 125^{\circ}\text{C}) 2\text{N}2453$ | ΔΤΑ | - | 10 | |
| 2N2453A | 1 -7 1 | _ | 5.0 | |

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

⁽²⁾ Lowest hee reading is taken as hee1 for this ratio.

| Rating | Symbol | Value | | Unit | | |
|---|----------------------|-------------|--------------|-------------|--|------|
| Collector-Emitter Voltage | VCEO | - | Vdc | | | |
| Collector-Base Voltage | VCBO | - | Vdc | | | |
| Emitter-Base Voltage | VEBO | 5 | Vdc | | | |
| Collector Current — Continuous | lc | 30 | | 30 | | mAdc |
| | | One Die | Both Die | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 1.72 | 600 3.43 | mW mW/℃ | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 600 3.43 | 1200 6.87 | mW mW/°C | | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to | +200 | °C | | |

2N2639 thru 2N2644

CASE 654-07, STYLE 1

DUAL

AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N2913 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|--|------------------|-----------|-------------|--------------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Sustaining Voltage(1) (IC = 10 mAdc, IB = 0) | | VCEO(sus) | 45 | _ | Vdc |
| Collector Cutoff Current (VCE = 5.0 Vdc, IB = 0) | | ICEO | - | 0.010 | μAdc |
| Collector Cutoff Current (VCB = 45 Vdc, IE = 0) (VCB = 45 Vdc, IE = 0, TA = +150°C) | | ІСВО | = | 0.010 10 | μAdc |
| Emitter Cutoff Current (VEB = 5.0 Vdc, IC = 0) | | ^I EBO | _ | 0.010 | μAdc |
| ON CHARACTERISTICS(1) | | | _ | | |
| DC Current Gain (IC = 10 µAdc, VCE = 5.0 Vdc) | 2N2639, 2N2640, 2N2641 2N2642, 2N2643, 2N2644 | hFE | 50 100 | 300 300 | _ |
| $(I_C = 10 \mu\text{Adc}, V_{CE} = 5.0 \text{Vdc}, T_A = -55^{\circ}\text{C})$ | 2N2639, 2N2640, 2N2641 2N2642, 2N2643, 2N2644 | | 10 20 | = | |
| $(I_C = 100 \mu Adc, V_{CE} = 5.0 Vdc)$ | 2N2639, 2N2640, 2N2641 2N2642, 2N2643, 2N2644 | | 55 110 | = | |
| (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc) | 2N2639, 2N2640, 2N2641 2N2642, 2N2643, 2N2644 | | 65 130 | _ | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 0.5 mAdc) | | VCE(set) | _ | 1.0 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 0.5 mAdc) | | VBE(sat) | 0.6 | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | _ |
| Current-Gain — Bandwidth Product ($I_C = 1.0 \text{ mAdc}$, $V_{CE} = 5.0 \text{ Vdc}$, $f = 20 \text{ MHz}$) | | ĺΤ | 40 | _ | MHz |
| Output Capacitance (VCB = 5.0 Vdc, IE = 0, f = 1.0 MHz) | | Cobo | | 8.0 | pF |
| Input Impedance (IC = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz, f_{E} = | -1.0 mA) | hib | 25 | 32 | ohms |
| Voltage Feedback Ratio (IC = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz, I _E = | – 1.0 mA) | h _{rb} | _ | 600 | X 10 ⁻⁶ |

2N2639 thru 2N2644

| Characteristic | | Symbol | Min | Max | Unit |
|--|--|---|------------|------------|-------|
| | 2N2639, 2N2640, 2N2641 2N2642, 2N2643, 2N2644 | hfe | 65 130 | 600 600 | _ |
| Output Admittance (IC = 1.0 mAdc, VCB = 5.0 Vdc, f = 1.0 kHz, IE = -1. | .0 mA) | h _{ob} | _ | 1.0 | μmhos |
| Noise Figure (IC = 10 μ Adc, V _{CB} = 5.0 Vdc, R _S = 10 k Ω , Bandwidth = 10 Hz to 15 kHz) | | NF | _ | 4.0 | dB |
| MATCHING CHARACTERISTICS | | | | | |
| DC Current Gain Ratio(2) (IC = 10 μAdc, VCE = 5.0 Vdc) | 2N2639, 2N2642 2N2640, 2N2643 | hFE1/hFE2 | 0.9 0.8 | 1.0 1.0 | _ |
| Base-Emitter Voltage Differential (I _C = 10 µAdc, V _{CE} = 5.0 Vdc) | 2N2639, 2N2642 2N2640, 2N2643 | VBE1-VBE2 | 1 1 | 5.0 10 | mVdc |
| Base-Emitter Voltage Differential Gradient (I _C = 10 μAdc, V _{CE} = 5.0 Vdc, T _A = -55 to +125°C) | 2N2639, 2N2642 2N2640, 2N2643 | Δ(V _{BE1} -V _{BE2}) ΔΤ _Α | 1 1 | 10 20 | μV/°C |

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%. (2) The lowest hpe reading is taken as hpe1 for this test.

| WANIFICIAL BATHAGS | | | | |
|---|-----------------------------------|-------------|-------------|----------------|
| Rating | Symbol | Ve | Unit | |
| Collector-Emitter Voltage | VCEO | | Vdc | |
| Collector-Base Voltage | V _{CBO} | 1 | Vdc | |
| Emitter-Base Voltage | VEBO | 7 | Vdc | |
| Collector Current — Continuous | lc | 500 | | mAdc |
| <u> </u> | | One Die | Both Die | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.3 1.72 | 0.6 3.43 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 5.7 | 2.0 11.4 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to | +200 | °C |

2N2652,A

CASE 654-07, STYLE 1 DUAL **AMPLIFIER TRANSISTOR NPN SILICON**

Refer to 2N2060,A for graphs.

| C unless otherwise noted \ |
|----------------------------|
| |

| Symbol | Min | Max | Unit |
|----------------------|--|--|---|
| | | | |
| V(BR)CEO | 60 | T _ | Vdc |
| | 100 | | Vdc |
| | 7.0 | | Vdc |
| ICBO | = | 0.010 15 | μAdc |
| EBO | | 0.010 | μAdc |
| | ' | | |
| hFE | 35 50 15 | 200 | - |
| V _{CE(sat)} | _ | 1.2 | Vdc |
| | | 0.9 | Vdc |
| | | <u> </u> | |
| fr | 60 | | MHz |
| Coho | | 15 | pF |
| | | 85 | pF |
| | 1.0 | 10.5 | kohms |
| | 20 | 35 | ohms |
| | 50 | 300 | _ |
| | | | μmhos |
| NF | _ | 8.0 | dB |
| | | <u> </u> | |
| hFE1/hFE2 | 0.85 0.85 | 1.0 1.0 | _ |
| Mana Manal | _ | 3.0 | mVdc |
| VBE1-VBE2 | _ | 3.0 | |
| | V(BR)CEO V(BR)CBO V(BR)EBO ICBO IEBO hFE VCE(sat) VBE(sat) fT Cobo Cibo hie hib hfe hoe NF | V(BR)CEO 60 V(BR)CBO 100 V(BR)EBO 7.0 ICBO — IEBO — hFE 35 50 15 VCE(sat) — VBE(sat) — fT 60 Cobo — Cibo — hie 1.0 hib 20 hfe 50 hoe — NF — hFE1/hFE2 0.85 0.85 0.85 | V(BR)CEO 60 — V(BR)CBO 100 — V(BR)EBO 7.0 — ICBO — 0.010 IEBO — 0.010 hFE 35 — 50 200 15 — VCE(sat) — 1.2 VBE(sat) — 0.9 fT 60 — — 15 Cibo — 85 hie 1.0 10.5 hib 10.5 hib 20 35 hfe 50 300 hoe — 50 NF — 8.0 hFE1/hFE2 0.85 1.0 0.85 1.0 0.85 1.0 |

 ⁽¹⁾ Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
 (2) The lowest of the two hFE readings is taken as hFE₁ for the purpose of measurement.

2N2720 2N2721

CASE 654-07, STYLE 1

DUAL AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MAXIMUM KATINGS | | | | | | |
|--|----------|-------------|------------|---------------|--|------|
| Rating | Symbol | Va | Unit | | | |
| Collector-Emitter Voltage | VCEO | 60 | | Vdc | | |
| Collector-Base Voltage | VCBO | 80 | | 80 | | Vdc |
| Emitter-Base Voltage | VEBO | 6 | Vdc | | | |
| Collector Current — Continuous | lc | 40 | | 40 | | mAdc |
| | | One Die | Both Die | | | |
| Total Device Dissipation @ T _A = 25°C Derste above 25°C | PD | 0.3 1.71 | 0.6 3.4 | Watt mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 0.6 3.4 | 1.2 6.8 | Watt mW/°C | | |
| Operating and Storage Junction Temperature Range | TJ, Tstg | -65 to +200 | | °C | | |

Refer to 2N2060 for graphs.

| ELECTRICAL CHARACTERISTICS (1A = 25°C unless otherwise) Characteristic | | Symbol | Min | Max | Unit |
|---|--------------------|--|----------------|---------------|--------|
| OFF CHARACTERISTICS | | 1 | | | |
| Collector-Emitter Breakdown Voltage(1) (I _C = 10 mAdc, I _B = 1 | 0) | V(BR)CEO | 60 | _ | Vdc |
| Collector Cutoff Current (VCE = 5.0 Vdc, lg = 0) | | ICEO | _ | 10 | nAdc |
| Collector Cutoff Current (VCB = 60 Vdc, IE = 0) (VCB = 60 Vdc, IE = 0, TA = 150°C) | | СВО | | 0.01 10 | μAdc |
| Emitter Cutoff Current (VEB = 5.0 Vdc, IC = 0) | | IEBO | _ | 10 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 100 µAdc, VCE = 5.0 Vdc) (IC = 1.0 mAdc, VCE = 5.0 Vdc) (IC = 10 mAdc, VCE = 5.0 Vdc) | | hFE | 30 35 42 | 120 — — | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 | mAdc) | V _{CE(sat)} | | 1.0 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mA | | V _{BE(sat)} | 0.65 | 0.85 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 10 |) Vdc, f = 20 MHz) | fτ | 80 | ,1 | MHz |
| Output Capacitance (VCB = 5.0 Vdc, IE = 0, f = 1.0 MHz) | | Cobo | _ | 6.0 | рF |
| Input Impedance (IE = 1.0 mAdc, VCB = 5.0 Vdc, f = 1.0 kHz | :) | hib | 25 | 32 | ohms |
| Voltage Feedback Ratio (I _E = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = | | h _{rb} | _ | 500 | X 10-6 |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 5.0 Vdc, f | = 1.0 kHz) | hfe | 30 | 200 | |
| Output Admittance (Ig = 1.0 mAdc, VCB = 5.0 Vdc, f = 1.0 k | | h _{ob} | | 1.0 | μmhos |
| MATCHING CHARACTERISTICS | | | | | |
| DC Current Gain Retio(2) (IC = 100 μAdc, VCE = 5.0 Vdc) 2N | 2720 2721 | hFE1/hFE2 | 0.9 0.8 | 1.0 1.0 | |
| | 2720 2721 | VBE1-VBE2 | <u>-</u> | 5.0 10 | mVdc |
| (II: m 100 proces after a second and a second a | 2720 12721 | Δ(V _{BE1} -V _{BE2}) | = | 0.8 1.6 | mV |
| | 12720 12721 | | _ | 1.0 2.0 | |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

⁽²⁾ The lower of the two hee readings is taken as hee1 for the purpose of measurement.

| MINDAMON INTINIO | | | | |
|---|-----------------------------------|-------------|------------|----------------|
| Rating | Symbol | Value | | Unit |
| Collector-Emitter Voltage | VCEO | 4 | Vdc | |
| Collector-Base Voltage | VCBO | 4 | Vdc | |
| Emitter-Base Voltage | VEBO | 5 | Vdc | |
| Collector Current — Continuous | lc | 40 | | mAdc |
| | | One Die | Both Die | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.3 1.7 | 0.6 3.4 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 0.6 3.4 | 1.2 6.8 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | °C |

2N2722

CASE 654-07, STYLE 1

DUAL AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N2920 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|--|------------------|---------------|--------|
| OFF CHARACTERISTICS | | | | 4 |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | V(BR)CEO | 45 | T - | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 μAdc, IE = 0) | V(BR)CBO | 45 | _ | Vdc |
| Collector Cutoff Current (VCE = 5.0 Vdc, IB = 0) | ICEO | - | 2.0 | nAdc |
| Collector Cutoff Current (V _{CB} = 30 Vdc, t_E = 0) (V _{CB} = 30 Vdc, t_E = 0, T _A = 150°C) | ICBO | = | 0.001 1.0 | μAdc |
| Emitter Cutoff Current (VEB = 5.0 Vdc, IC = 0) | ¹EBO | _ | 1.0 | nAdc |
| ON CHARACTERISTICS | | | • | |
| DC Current Gain (I _C = 1.0 μ Adc, V _{CE} = 5.0 Vdc) (I _C = 10 μ Adc, V _{CE} = 5.0 Vdc) (I _C = 0.1 mAdc, V _{CE} = 5.0 Vdc) | hFE | 50 100 125 | 250 — — | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 0.5 mAdc) | V _{CE(sat)} | _ | 1.0 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 0.5 mAdc) | V _{BE(sat)} | 0.65 | 0.85 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | • |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 10 Vdc, f = 20 MHz) | fŢ | 100 | _ | MHz |
| Output Capacitance (VCB = 5.0 Vdc, IE = 0, f = 1.0 MHz) | C _{obo} | _ | 6.0 | pF |
| Input Impedance (I _E = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) | h _{ib} | 25 | 32 | ohms |
| Voltage Feedback Ratio (IE = 1.0 mAdc, VCB = 5.0 Vdc, f = 1.0 kHz) | h _{rb} | _ | 600 | X 10-6 |
| Small-Signal Current Gain (IE = 0.1 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | h _{fe} | 100 | 700 | _ |
| Output Admittance (IE = 1.0 mAdc, VCB = 5.0 Vdc, f = 1.0 kHz) | h _{ob} | _ | 1.0 | μmhos |
| Noise Figure (IC = 10 μ Adc, VCE = 5.0 Vdc, Rs = 10 k Ω , f = 10 Hz to 15.7 kHz) | NF | _ | 4.0 | dB |
| MATCHING CHARACTERISTICS | | | | |
| DC Current Gain Ratio(2) (I _C = 1.0 µAdc, V _{CE} = 5.0 Vdc) | hFE1/hFE2 | 0.9 | 1.0 | _ |
| Base-Emitter Voltage Differential (I _C = 10 μAdc, V _{CE} = 5.0 Vdc) | VBE1-VBE2 | _ | 5.0 | mVdc |
| Base-Emitter Voltage Differential Change Due to Temperature ($I_C = 10 \mu Adc$, $V_{CE} = 5.0 Vdc$, $T_A = -55 to +25^{\circ}C$) ($I_C = 10 \mu Adc$, $V_{CE} = 5.0 Vdc$, $T_A = +25 to +125^{\circ}C$) | Δ(V _{BE1} -V _{BE2}) | | 0.8 1.0 | mVdc |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

⁽²⁾ The lower of the two hee readings is taken as hee1 for the purpose of measurement.

2N2723

CASE 20-23, STYLE 8 TO-72 (TO-206AF)

DARLINGTON TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MAXIMON DATINGS | | | |
|---|-----------------------------------|-------------|---------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage (Base 1 and Base 2 open) | V _{CE2O} | 60 | Vdc |
| Collector-Base Voltage | V _{CB1} | 80 | Vdc |
| Emitter-Base Voltage | V _{E2B1} | 12 | Vdc |
| Collector Current — Continuous | lc | 40 | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.5 2.9 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.8 10.5 | Watts mW/℃ |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | ℃ |

Refer to 2N9S8 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|-----------------------|------|------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, Ig1 = 0) | V(BR)CE2O | 60 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _{E2} = 0) | V(BR)CB1O | 80 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _{E2} = 10 µAdc, I _C = 0) | V(BR)E2B1O | 12 | _ | Vdc |
| Collector Cutoff Current (V _{CB1} = 60 Vdc, I _E = 0) (V _{CB1} = 60 Vdc, I _E = 0, T _A = 150°C) | ICB1O | _ | 0.01 10 | μAdc |
| Emitter Cutoff Current (VB1E2 = 10 Vdc, IC = 0) | lE2B1O | _ | 10 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 10 mAdc, V _{CE2} = 5.0 Vdc, I _{B2} = 0) | hFE | 2000 | 10,000 | - |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig1 = 1.0 mAdc) | VCE2(sat) | | 1.0 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, Ig1 = 1.0 mAdc) | V _{BE2(sat)} | _ | 1.7 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | , |
| Output Capacitance (V _{CB1} = 10 Vdc, I _{E2} = 0, f = 140 kHz) | C _{ob1o} | | 10 | pF |
| Small-Signal Current Gain (I _C = 10 mAdc, V _{CE2} = 5.0 Vdc, f = 1.0 kHz) | h _{fe} | 1500 | 15,000 | _ |
| Current Gain — Bandwidth Product (Each Unit) (IC = 10 mAdc, VCE1 or VCE2 = 10 Vdc, f = 20 MHz) | h _{fe} | 5.0 | _ | _ |
| Noise Figure (Input Stage Only) (I _C = 50 μ Adc, V _{CE} = 5.0 Vdc, R _S = 3.0 kohms, f = 1.0 kHz, BW = 100 Hz) | NF | _ | 10 | dΒ |

⁽¹⁾ Pulse Test: Pulse Width ≤ 12 ms, Duty Cycle ≤ 2.0%.

| TIPOLITICATINGO | | | |
|---|-----------------------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage (Base 1 and Base 2 open) | V _{CE2O} | 40 | Vdc |
| Collector-Base Voltage | V _{CB1O} | 60 | Vdc |
| Emitter-Base Voltage (Pin 4 to Pin 2) | V _{E2B1O} | 15 7.5 | Vdc |
| Collector Current — Continuous | lc | 200 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.5 2.9 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.8 10.5 | Watts mW/°C |
| Operating and Storage Junction | T _J , T _{stg} | -65 to +200 | °C |

2N2785

CASE 22-03, STYLE 8 TO-72 (TO-206AF) DARLINGTON TRANSISTOR

NPN SILICON

Refer to 2N998 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|---|-------------------|---------------------|------------|--------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 20 mAdc, Ig1 = 0) | V(BR)CEO2O | 40 | | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 µAdc, I _{E2} = 0) | V(BR)CBO10 | 60 | - | Vdc |
| Emitter-Base Breakdown Voltage (I _{E2} = 100 μAdc, I _C = 0) | V(BR)E2BO1O | 15 | _ | Vdc |
| Collector Cutoff Current (VCE = 20 Vdc, lg = 0) | ICEO | _ | 500 | nAdc |
| Collector Cutoff Current (V _{CB1} = 30 Vdc, I_E = 0) (V _{CB1} = 30 Vdc, I_E = 0, T_A = 150°C) | Ісво | = | 0.05 10 | μAdc |
| Emitter Cutoff Current (VE2B1 = 5.0 Vdc, I _C = 0) | IEBO | | 20 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain(1) (IC = 1.0 mAdc, V _{CE2} = 4.0 Vdc) (IC = 10 mAdc, V _{CE2} = 5.0 Vdc) (I _C = 100 mAdc, V _{CE2} = 5.0 Vdc) | hFE | 600 1200 2000 | 20,000 | _ |
| Collector-Emitter Saturation Voltage (I _C = 15 mAdc, I _{B1} = 3.0 mAdc) | VCE(sat) | _ | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Output Capacitance (V _{CB1} = 10 Vdc, I _{E2} = 0, f = 1.0 MHz) | C _{ob1o} | ~ | 30 | pF |
| Input Impedance (IC = 1.0 mAdc, V _{CB1} = 5.0 Vdc, f = 1.0 kHz) | h _{ib} | 30 | 80 | Ohms |
| Voltage Feedback Ratio (IC = 1.0 mAdc, V _{CE2} = 5.0 Vdc, f = 1.0 kHz) | h _{rb} | _ | 10 | X 10-4 |
| Small-Signal Current Gain (IC = 1.0 mAdc, V _{CE2} = 5.0 Vdc, f = 1.0 kHz) | h _{fe} | 600 | _ | _ |
| Current Gain — High Frequency (IC = 1.0 mAdc, V _{CE2} = 5.0 Vdc, f = 10 MHz) | h _{fe} | 1.0 | _ | |
| Output Admittance (IC = 1.0 mAdc, VCB1 = 5.0 Vdc, f = 1.0 kHz) | h _{ob} | | 0.5 | μmhos |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

2N2903

CASE 654-07, STYLE 1

DUAL AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| manufacture (Internation | | | | |
|---|-----------------------------------|----------------------|-------------|----------------|
| Rating | Symbol | Va | lue | Unit |
| Collector-Emitter Voltage | VCEO | 3 | 30 | Vdc |
| Collector-Base Voltage | VCBO | 6 | 50 | Vdc |
| Emitter-Base Voltage | VEBO | 7.0 | | Vdc |
| Collector Current — Continuous | lc | 50 | | mAdc |
| | | One Die | Both Die | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 200 1.14 | 300 1.71 | mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 0.6 1.2 3.43 6.86 | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | က |

Refer to 2N2920 for graphs.

| VCEO(sus) V(BR)CBO V(BR)EBO ICBO | 30 60 7.0 — | | Vdc Vdc Vdc μAdc |
|---|--|---|---------------------------|
| V(BR)CBO V(BR)EBO ICBO | 7.0 — — | 0.01 15 | Vdc Vdc μAdc |
| V(BR)CBO V(BR)EBO ICBO | 7.0 — — | 0.01 15 | Vdc Vdc μAdc |
| V(BR)EBO ICBO IEBO | 7.0 — — | 0.01 15 | Vdc μAdc |
| ICBO | | 15 | μAdc |
| IEBO | | 15 | ļ . |
| 1 | | 0.01 | |
| h 1 | | | μAdc |
| h | | | |
| IFE | 60 25 125 60 | - - 625 - | _ |
| V _{CE(sat)} | _ | 1.0 | Vdc |
| V _{BE(sat)} | | 0.9 | Vdc |
| | | | |
| fT | 60 | | MHz |
| Cobo | | 8.0 | ρF |
| C _{ibo} | - | 10 | pF |
| hie | 1.0 | | kohm |
| h _{ib} | 20 | 30 | ohms |
| h _{re} | - | 6.0 | X 10-4 |
| h _{rb} | 1 | 5.0 | X 10-4 |
| h _{fe} | 150 | 600 | _ |
| hoe | 5.0 | 30 | μmhos |
| hob | _ | 0.2 | μmho |
| NF | | 7.0 | dB |
| | | | |
| hFE1/hFE2 | 0.8 | 1.0 | |
| IVBE1-VBE2 | | 10 | mVdc |
| Δ(V _{BE1} -V _{BE2}) ΔΤ _A | _ | 20 | μV/°C |
| | VBE(sat) fT Cobo Cibo hie hib hre hrb hfe hoe hob NF hFE1/hFE2 iVBE1-VBE2 Δ(VBE1-VBE2) | 25 125 60 VCE(sat) — VBE(sat) — fT 60 Cobo — Cibo — hie 1.0 hib 20 hre — hrb — hfe 150 hoe 5.0 hob — NF — hFE1/hFE2 0.8 IVBE1-VBE2 — Δ(VBE1-VBE2) — | 25 |

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%. (2) Lowest hFE reading is taken as hFE1 for this ratio.

| MAXIMUM KATINGS | | | | |
|--|-----------------------------------|--------------------------|------------------|-------------|
| Rating | Symbol | 2N2913 thru 2N2918 | 2N2919 2N2920 | Unit |
| Collector-Emitter Voltage | VCEO | 45 | 60 | Vdc |
| Collector-Base Voltage | V _{CBO} | 45 | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | | Vdc |
| Collector Current — Continuous | lc | 30 | | mAdc |
| | | One Die | Both Die | |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 300 1.7 | 500 2.86 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD . | 750 4.3 | 1500 8.6 | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 65 te | | |

2N2913 thru 2N2920

JAN, JTX, JTXV, JANS AVAILABLE CASE 654-07, STYLE 1

DUAL AMPLIFIER TRANSISTOR

NPN SILICON

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|---|----------------------|----------------|-----------------|----------------|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, I _B = 0) | 2N2913 thru 18, 2N2919, 2N2920 | V(BR)CEO(sus) | 45 60 | | = | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | 2N2913 thru 18, 2N2919, 2N2920 | V(BR)CBO | 45 60 | _ | | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | | V(BR)EBO | 6.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCE = 5.0 Vdc, IB = 0) | | ICEO | _ | _ | 0.002 | μAdc |
| Collector Cutoff Current (VCB = 45 Vdc, IE = 0) | 2N2913 thru 18, 2N2919, 2N2920 | ІСВО | _ | = | 0.010 0.002 | μAdc |
| (VCB = 45 Vdc, IE = 0, TA = 150°C) | All Types | | _ | _ | 10 | |
| Emitter Cutoff Current (VEB = 5.0 Vdc, I _C = 0) | | IEBO | | | 0.002 | μAdc |
| ON CHARACTERISTICS | | | | | , | |
| DC Current Gain(1) (IC = 10 μAdc, VCE = 5.0 Vdc) | 2N2913,15,17,19, 2N2914,16,18,20 | pEE | 60 150 | = | 240 600 | _ |
| $(I_C = 10 \ \mu Adc, V_{CE} = 5.0 \ Vdc, T_A = -55^{\circ}C)$ | 2N2913,15,17,19, 2N2914,16,18, 2N2920 | | 15 30 40 | <u>-</u> - | = = | |
| $(I_C = 100 \ \mu Adc, V_{CE} = 5.0 \ Vdc)$ | 2N2913,15,17,19, 2N2914,16,18,20 | | 100 225 | _ | = | |
| (IC = 1.0 mAdc, V_{CE} = 5.0 Vdc) | 2N2913,15,17,19, 2N2914,16,18,20 | | 150 300 | _ | | |
| Collector-Emitter Saturation Voltage (IC = 1.0 mAdc, IB = 0.1 mAdc) | | V _{CE(sat)} | _ | _ | 0.35 | Vdc |
| Base-Emitter On Voltage (IC = 100 μAdc, VCE = 5.0 Vdc) | | VBE(on) | | | 0.7 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | _ | | |
| Current-Gain — Bandwidth Product (IC = 500 µAdc, VCE = 5.0 Vdc, f = 20 MHz) | | fτ | 60 | _ | - | MHz |

2N2913 thru 2N2920

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

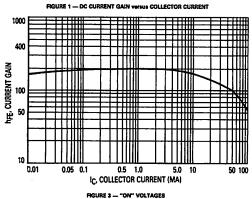
| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|-------------------------------------|-----------------|-----|------------|------------|-------|
| Output Capacitance (VCB = 5.0 Vdc, I _E = 0, f = 140 kHz) | | Cobo | _ | 4.0 | 6.0 | pF |
| Input Impedance (I _C = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) | | hib | 25 | 28 | 32 | ohms |
| Output Admittance (IC = 1.0 mAdc, V _{CB} = 5.0 Vdc, f = 1.0 kHz) | | h _{ob} | _ | - | 1.0 | μmhos |
| Noise Figure (I _C = 10 μ Adc, V _{CE} = 5.0 Vdc, R _S = 10 k Ω , f = 1.0 kHz, BW = 200 Hz) | 2N2914,16,18,20, 2N2913,15,17,19 | NF | = | 2.0 3.0 | 3.0 4.0 | dB |
| (I _C = 10 μ Adc, V _{CE} = 5.0 Vdc, R _S = 10 k Ω , f = 10 Hz to 15.7 kHz, BW = 10 kHz) | 2N2914,16,18,20, 2N2913,15,17,19 | | _ | 2.0 3.0 | 3.0 4.0 | |

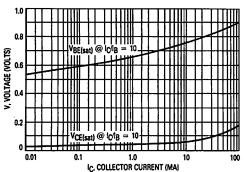
MATCHING CHARACTERISTICS

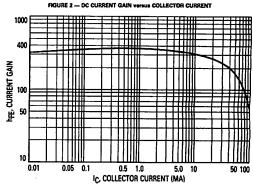
| DC Current Gain Ratio(2) (IC = 100 μAdc, VCE = 5.0 Vdc) | 2N2917,18, 2N2915,16,19,20 | hFE1/hFE2 | 0.8 0.9 | _ | 1.0 | _ |
|--|-------------------------------|--------------|------------|----------|-----|------|
| Base-Emitter Voltage Differential | | VBE1-VBE2 | | | | mVdc |
| (IC = 10 µAdc to 1.0 mAdc, VCE = 5.0 Vdc) | 2N2917,18, | | _ | l — | 10 | 1 |
| | 2N2915,16,19,20 | | _ | _ | 5.0 | |
| (IC = 100 µAdc, VCE = 5.0 Vdc) | 2N2917,18, | | _ | _ | 5.0 | |
| | 2N2915,16,19,20 | l i | | – | 3.0 | |
| Base-Emitter Voltage Differential Change Due to 1 (IC = 100 μAdc, VCE = 5.0 Vdc, | Temperature | Δ(VBE1-VBE2) | | | | mVdc |
| $T_{\Delta} = -55^{\circ}\text{C to} + 25^{\circ}\text{C}$ | 2N2917,18, | | _ | ا _ | 1.6 | |
| • | 2N2915,16,19,20 | | _ | _ | 0.8 | ļ |
| (IC = 100 µAdc, VCE = 5.0 Vdc, | 2N2917,18 | | _ | _ | 2.0 | ļ |
| T _A = +25°C to +125°C) | 2N2915,16,19,20 | | _ | _ | 1.0 | ł |

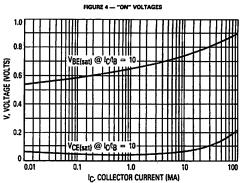
⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

⁽²⁾ The lowest hee reading is taken as hee1 for this ratio.









| INDOMINION INTO | | | | | | |
|---|-----------------------------------|-------------|-------------|----------------|--|-----|
| Rating | Symbol | Value | | Unit | | |
| Collector-Emitter Voltage | VCEO | 4 | 45 | | | |
| Collector-Base Voltage | VCBO | 45 | | Vdc | | |
| Emitter-Base Voltage | VEBO | 5.0 | | 5.0 | | Vdc |
| Collector Current — Continuous | lc | 30 | | mAdc | | |
| | | One Die | Both Die | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 250 1.67 | 350 2.33 | mW mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 0.7 4.67 | 1.4 9.33 | Watts mW/°C | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | °C | | |

2N3043 thru 2N3048

CASE 610A-04, STYLE 1

DUAL

AMPLIFIER TRANSISTOR

NPN SILICON

| Characteristic | | Symbol | Min | Max | Unit |
|--|--|----------------------|--------------|-------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, Ig = 0) | | V(BR)CEO | 45 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 45 Vdc, IE = 0) (VCB = 45 Vdc, IE = 0, TA = +150°C) | | ІСВО | = | 0.010 10 | μAdc |
| Emitter Cutoff Current (VEB = 4.0 Vdc, I _C = 0) | | ^I EBO | _ | 0.010 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(1) (I _C = 10 μAdc, V _{CE} = 5.0 Vdc) | 2N3043, 2N3044, 2N3045 2N3046, 2N3047, 2N3048 | hFE | 100 50 | 300 200 | _ |
| (IC = 1.0 mAde, VCE = 5.0 Vdc) | 2N3043, 2N3044, 2N3045 2N3046, 2N3047, 2N3048 | | 130 65 | | |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 0.5 mAdc) | | V _{CE(sat)} | _ | 1.0 | Vdc |
| Base-Emitter On Voltage (IC = 10 mAdc, VCE = 5.0 Vdc) | | V _{BE} | 0.6 | 8.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 20 MHz) | | fΤ | 30 | _ | MHz |
| Output Capacitance (VCB = 5.0 Vdc, IE = 0, f = 1.0 MHz) | | C _{obo} | _ | 8.0 | pF |
| Input Impedance (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 kHz) | 2N3043, 2N3044, 2N3045 2N3046, 2N3047, 2N3048 | h _{ie} | 3.2k 1.6k | 19k 13k | Ohms |
| Small-Signal Current Gain (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 kHz) | 2N3043, 2N3044, 2N3045 2N3046, 2N3047, 2N3048 | h _{fe} | 130 65 | 600 400 | _ |
| Output Admittance (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) | | h _{oe} | | 100 70 | μmho |
| Noise Figure (IC = 10 μ Adc, VCE = 5.0 Vdc, RS = 10 kohms, Ba | andwidth = 10 Hz to 15.7 kHz) | NF | _ | 5.0 | dB |

2N3043 thru 2N3048

| Characteristic | | Symbol | Min | Max | Unit |
|---|----------------------------------|---|------------|------------|-------|
| MATCHING CHARACTERISTICS | | | | · | • |
| DC Current Gain Ratio(2) (I _C = 10 μAdc, V _{CE} = 5.0 Vdc) | 2N3043, 2N3046 2N3044, 2N3047 | hFE1/hFE2 | 0.9 0.8 | 1.0 1.0 | _ |
| Base-Emitter Voltage Differential (IC = 10 μAdc, VCE = 5.0 Vdc) | 2N3043, 2N3046 2N3044, 2N3047 | V _{BE1} -V _{BE2} | | 5.0 10 | mVdc |
| Base-Emitter Voltage Differential Temperature Gradient (IC = 10 μ Adc, VCE = 5.0 Vdc, TA = -55 to +125°C) | 2N3043, 2N3046 2N3044, 2N3047 | Δ(V _{BE1} -V _{BE2}) ΔΤ _Α | = | 10 20 | μV/°C |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

⁽²⁾ The lowest hee reading is taken as hee1 for this test.

| Rating | Symbol | Value | | Unit |
|---|----------------------|-------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 1 | 15 | Vdc |
| Collector-Emitter Voltage | VCER | 20 | | Vdc |
| Collector-Base Voltage | V _{CBO} | 40 | | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc |
| | | One Die | Both Die | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.3 1.72 | 0.4 2.28 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 0.75 4.3 | 1.5 8.55 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | Tj, T _{stg} | -65 to +200 | | °C |

2N3425

CASE 654-07, STYLE 1

DUAL

AMPLIFIER TRANSISTORS

NPN SILICON

Refer to MD2369,A,B for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|--|-----------------------|----------------|-------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 30 mAdc, RBE ≤ 10 ohms) | V _{CER(sus)} | 20 | | Vdc |
| Collector-Emitter Sustaining Voltage(1) (IC = 10 mAdc, IB = 0) | V _{CEO(sus)} | 15 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | V(BR)CBO | 40 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 20 Vdc, VEB(off) = 0.25 Vdc, TA = 125°C) | CEX | _ | 15 | μAdc |
| Collector Cutoff Current (V _{CB} = 20 Vdc, ! _E = 0) (V _{CB} = 20 VDc, ! _E = 0, T _A = 150°C) | Ісво | = | 0.025 15 | μAdc |
| Emitter Cutoff Current (VEB = 4.0 Vdc, IC = 0) | [[] EBO | _ | 0.2 | μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 0.5 mAdc, V _{CE} = 1.0 Vdc) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc, T _A = -55°C) | pEE | 12 30 12 | 120 — | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 7.0 mAdc, I _B = 0.7 mAdc, T _A = -55°C to +125°C) | VCE(sat) | - | 0.4 0.5 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 7.0 mAdc, I _B = 0.7 mAdc, $T_A = -55^{\circ}C$) | V _{BE(sat)} | 0.7 — | 0.85 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 20 mAdc, VCE = 10 Vdc, f = 100 MHz) | fŢ | 300 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 140 kHz) | Cobo | _ | 6.0 | ρF |
| Input Capacitance (VBE = 0.5 Vdc, IC = 0, f = 140 kHz) | Cibo | _ | 9.0 | pF |
| Small-Signal Current Gain (IC = 10 mAdc, VCE = 1.0 Vdc, f = 1.0 kHz) | hfe | 20 | | _ |
| Real Part of Input Impedance (IC = 10 mAdc, VCE = 10 Vdc, f = 300 MHz) | Re(h _{ie}) | _ | 50 | Ohms |
| SWITCHING CHARACTERISTICS | | | | |
| Storage Time (I _C = 10 mAdc, I _{B1} = 10 mAdc, I _{B2} = 10 mAdc) | t _S | _ | 40 | ns |
| Turn-On Time (V _{CC} = 3.0 Vdc, V _{EB(off)} = 2.0 Vdc, I_C = 10 mAdc, I_{B1} = 3.0 mAdc) | ton | _ | 50 | ns |
| Turn-Off Time (V _{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = 3.0 mAdc, I_{B2} = 1.0 mAdc) | ^t off | _ | 90 | ns |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 1.0%.

2N3726 2N3727

CASE 654-07, STYLE 1

DUAL AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| WAXIMOW RATINGS | _ | | | | | |
|---|-----------------------------------|--------------|--------------|--------------|--|------|
| Rating | Symbol | Va | lue | Unit | | |
| Collector-Emitter Voltage | VCEO | 45 | | Vdc | | |
| Collector-Base Voltage | VCBO | 4 | 15 | Vdc | | |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc | | |
| Base Current | В | 100 | | 100 | | mAdc |
| Collector Current — Continuous | ភ | 300 | | 300 | | mAdc |
| | | One Die | Both Die | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 400 2.29 | 500 2.86 | mW mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 0.85 4.85 | 1.4 8.0 | Watt mW/℃ | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | ဗ | | |
| Collector ₁ to Collector ₂ Voltage Voltage rating any lead to case | V _{C1} V _{C2} | ±200 ±200 | | Vdc Vdc | | |

Refer to MD2905,A for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|-------------------------|-------------|--------------------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | V(BR)CEO | 45 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.01 mAdc, IE = 0) | V(BR)CBO | 45 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 0.01 mAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0) (VCB = 30 Vdc, IE = 0, TA = 150°C) | ІСВО | _ | 10 10 | nAdc µAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc , IC = 0) | IEBO | _ | 0.1 | μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 0.01 mAdc, VCE = 5.0 Vdc) (IC = 0.1 mAdc, VCE = 5.0 Vdc) (IC = 1.0 mAdc, VCE = 5.0 Vdc) (IC = 50 mAdc, VCE = 5.0 Vdc) (IC = 50 mAdc, VCE = 5.0 Vdc)(1) | pEE | 80 120 135 115 | 350 | _ |
| Collector-Emitter Saturation Voltage(1) (I _C = 50 mAdc, I _B = 2.5 mAdc) | VCE(sat) | _ | 0.25 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 50 mAdc, IB = 2.5 mAdc) | VBE(sat) | · - · | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product(2) (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 20 MHz) (I _C = 50 mAdc, V _{CE} = 20 Vdc, f = 100 MHz) | fT | 60 200 | _ 600 | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | _ | 8.0 | pF |
| Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | C _{ibo} | _ | 30 | pF |
| Input Impedance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | hie | - | 11.5 | kohm |
| Voltage Feedback Ratio (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{re} | | 1500 | X 10 ⁻⁶ |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{fe} | 135 | 420 | |

2N3726, 2N3727

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|---|------------------|--|------------|------------|-------|
| Output Admittance (IC = 1.0 kHz) | | h _{oe} | _ | 80 | μmhos |
| Noise Figure (IC = 30 μ Adc, V _{CE} = 5.0 Vdc, R _S = 10 kohms, f = 1.0 kHz, B.W. = 20 | 00 Hz) | NF | _ | 4.0 | dB |
| MATCHING CHARACTERISTICS | | | | - | |
| DC Current Gain Ratio(3) (IC = 0.1 mAdc to 1.0 mAdc, VCE = 5.0 Vdc) | | hFE1/hFE2 | 0.9 | 1.0 | _ |
| Base-Emitter Voltage Differential (IC = 0.1 mAdc to 1.0 mAdc, VCE = 5.0 Vdc) | 2N3726 2N3727 | VBE1-VBE2 | = | 5.0 2.5 | mVdc |
| Base-Emitter Differential Change Due to Temperature (I _C = 0.1 mAdc to 1.0 mAdc, V _{CE} = 5.0 Vdc, T _A = -55°C to +25°C) | 2N3726 2N3727 | Δ(V _{BE1} -V _{BE2}) | · <u>-</u> | 1.6 0.8 | mVdc |
| (Ic = 0.1 mAdc to 1.0 mAdc. Vc= = 5.0 Vdc. Ta = +25°C to +125°C) | 2N3726 | <u> </u> | | 2.0 | |

2N3727

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

⁽²⁾ fT is defined as the frequency at which $|\mathbf{h}_{fe}|$ extrapolates to unity. (3) For purposes of this ratio, the lowest hFE reading is taken as hFE1.

2N3806 thru 2N3810,A 2N3811,A

CASE 610A-04, STYLE 1

2N3812 thru 2N3816,A 2N3817,A

CASE 654-07, STYLE 1

2N3810, 2N3811 — JAN, JTX, JTXV AVAILABLE

DUAL AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

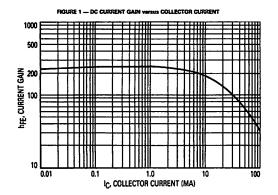
| Rating | Symbol | Va | lue | Unit |
|---|----------------------|------------------|---------|-------------|
| Collector-Emitter Voltage | VCEO | 60 | | Vdc |
| Collector-Base Voltage | V _{CBO} | 60 | | Vdc |
| Emitter-Base Voltage | VEBO | 5 | .0 | Vdc |
| Collector Current — Continuous | lc | 5 | 0 | mAdc |
| | | One Die Both Die | | } |
| Total Device Dissipation @ T _A = 25°C Metal Can (2N3806 thru 2N3810,A, 2N3811,A) Derate above 25°C | PD | 500 2.86 | 600 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Flat Package (2N3812 thru 2N3816,A, 2N3817,A) Derate above 25°C | PD | 250 | 250 350 | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | | °C |

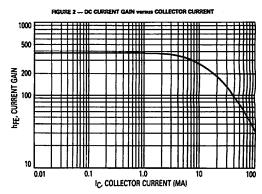
| Characteristic | | Symbol | Min | Max | Unit |
|--|--|------------------|------------|-------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | | V(BR)CEO | 60 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | | V(BR)CBO | 60 | - | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 50 Vdc, I _E = 0) (V _{CB} = 50 Vdc, I _E = 0, T _A = 150°C) | 2N3816,17,12,13,14,15 | ІСВО | 1 1 | 0.01 10 | μAdc |
| Emitter Cutoff Current (VBE = 4.0 Vdc, IC = 0) | | ^I EBO | - | 20 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(1) (IC = 1.0 μ Adc, VCE = 5.0 Vdc) | 2N3807,9,11,A,13,15,17,A | hFE | 75 | _ | _ |
| (I _C = 10 μ Adc, V _{CE} = 5.0 Vdc) | 2N3806,8,10,A,12,14,16,A 2N3807,9,11,A,13,15,17,A | | 100 225 | _ | |
| $(I_C = 100 \ \mu Adc, V_{CE} = 5.0 \ Vdc)$ | 2N3806,8,10,A,12,14,16,A 2N3807,9,11,A,13,15,17,A | | 150 300 | 450 900 | |
| $(I_C = 100 \ \mu Adc, V_{CE} = 5.0 \ Vdc, T_A = -55^{\circ}C)$ | 2N3806,8,10,A,12,14,16,A 2N3807,9,11,A,13,15,17,A | | 75 150 | <u> </u> | |
| $(I_C = 500 \ \mu Adc, V_{CE} = 5.0 \ Vdc)$ | 2N3806,8,10,A,12,14,16,A 2N3807,9,11,A,13,15,17,A | | 150 300 | 450 900 | |
| (I _C = 1.0 mAde, V_{CE} = 5.0 Vdc) | 2N3806,8,10,A,12,14,16,A 2N3807,9,11,A,13,15,17,A | | 150 300 | 450 900 | |
| (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) | 2N3806,8,10,A,12,14,16,A 2N3807,9,11,A,13,15,17,A | | 125 250 | = | |
| Collector-Emitter Saturation Voltage(1) (I _C = 100 μ Adc, I _B = 1.0 μ A) (I _C = 1.0 mAdc, I _B = 100 μ Adc) | 2N3814, 2N3815 | VCE(sat) | = | 0.2 0.25 | Vdc |
| Base-Emitter Saturation Voltage(1) (I _C = 100 μAdc, I _B = 10 μAdc) (I _C = 1.0 mAdc, I _B = 100 μAdc) | | VBE(sat) | = | 0.7 0.8 | Vdc |

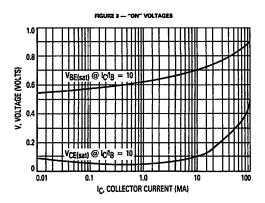
2N3806 thru 2N3810,A, 2N3811,A, 2N3812,A, 2N3816,A, 2N3817,A

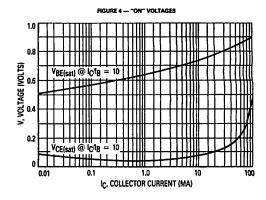
| ELECTRICAL CHARACTERISTICS (continued) (TA | = 25°C unless otherwise noted | 1.) | | | |
|--|---|--|--------------------|-------------------|--------|
| Characteristic | | Symbol | Min | Max | Unit |
| Base-Emitter On Voltage (I _C = 100 μAdc, V _{CE} = 5.0 Vdc) | | V _{BE(on)} | _ | 0.7 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product ($I_C = 500 \mu Adc$, $V_{CE} = 5.0 Vdc$, $f = 30 MHz$) ($I_C = 1.0 mAdc$, $V_{CE} = 5.0 Vdc$, $f = 100 MHz$) | | fτ | 30 100 | _ 500 | MHz |
| Output Capacitance (VCB = 5.0 Vdc, IE = 0, f = 100 kHz) | | Cobo | _ | 4.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = 0, f = 100 kHz) | | C _{ibo} | | 8.0 | pF |
| Input Impedance (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | 2N3806,8,10,A,12,14,16,A 2N3807,9,11,A,13,15,17,A | h _{ie} | 3.0 10 | 30 40 | Ω |
| Voltage Feedback Ratio (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | | h _{re} | _ | 25 | X 10-4 |
| Small-Signal Current Gain (IC = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) | 2N3806,B,10,A,12,14,16,A 2N3807,9,11,A,13,15,17,A | h _{fe} | 150 300 | 600 900 | _ |
| Output Admittance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | | h _{oe} | 5.0 | 60 | μmhos |
| Noise Figure (I _C = 100 μ Adc, V _{CE} = 10 Vdc, R _G = 3.0 kohms f = 100 Hz, BW = 20 Hz | 2N3806,8,10,A,12,14,16,A 2N3807,9,11,A,13,15,17,A | NF | | 7.0 4.0 | dB |
| Spot f = 1.0 kHz, BW = 200 Hz | 2N3806,8,10,A,12,14,16,A 2N3807,9,11,A,13,15,17,A | | _ | 3.0 1.5 | |
| f = 10 kHz, BW = 2.0 kHz) | 2N3806,8,10,A,12,14,16,A 2N3807,9,11,A,13,15,17,A | | · <u> </u> | 2.5 1.5 | |
| Broadband Noise Bandwidth 10 Hz to 15.7 kHz | 2N3806,8,10,A,12,14,16,A 2N3807,9,11,A,13,15,17,A | | _ | 3.5 2.5 | |
| MATCHING CHARACTERISTICS | | <u>1</u> | | | |
| DC Current Gain Ratio(2) | | hFE1/hFE2 | | | I – |
| (IC = 100 µAdc, VCE = 5.0 Vdc) | 2N3608,9,14,15 2N3810,11,16,17 2N3810A,11A,16A,17A | | 0.8 0.9 0.95 | 1.0 1.0 1.0 | |
| (I _C = 100 µAdc, V _{CE} = 50 Vdc, T _A = -55 to +12 | 5°C) 2N3810A,11A,16A,17A | | 0.85 | 1.0 | |
| Base-Emitter Voltage Differential (I _C = 10 μAdc to 10 mAdc, V _{CE} = 5.0 Vdc) | 2N3808,9,14,15 2N3810,A,11,A,16,A,17,A | VBE1-VBE2 | _ | 8.0 5.0 | mVdc |
| (I _C = 100 μAdc, V _{CE} = 5.0 Vdc) | 2N3808,9,14,15 2N3810,11,16,17 2N3810A,11A,16A,17A | | <u>-</u> | 5.0 3.0 1.5 | |
| Base-Emitter Voltage Differential Change Due to Tem (IC = 100 μAdc, VCE = 5.0 Vdc, TA = -55 to +25 | perature | Δ(V _{BE1} -V _{BE2}) | | | mVdc |
| | 2N3808,9,14,15 2N3810,11,16,17 2N3810A,11A,16A,17A | | = | 1.6 0.8 0.4 | |
| (I _C = 100 μAdc, V _{CE} = 5.0 Vdc, T _A = +25 to +12 | 25°C) 2N3808,9,14,15 2N3810,11,16,17 2N3810A,11A,16A,17A | | = | 2.0 1.0 0.5 | |

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%. (2) The lowest hre reading is taken as hre1 for this ratio.









| MAXIMUM HATINGS | | | | | | |
|---|----------------------|----------------|--------------|---------------|--|------|
| Rating | Symbol | Value | | Value | | Unit |
| Collector-Emitter Voltage | VCEO | 40 | | Vdc | | |
| Collector 1 to Collector 2 Voltage Voltage Rating any Lead to Case | VC1C2 | ± 120 ± 120 | | | | Vdc |
| Collector-Base Voltage | VCBO | 6 | Vdc | | | |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc | | |
| Collector Current — Continuous | lc | 600 | | mAdc | | |
| | | One Die | Both Die | 1 | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.25 1.67 | 0.35 2.34 | Watt mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 0.7 4.67 | 1.4 9.34 | Watts | | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to | °C | | | |

2N3838

CASE 610A-04, STYLE 1
COMPLEMENTARY DUAL
AMPLIFIER TRANSISTOR

NPN/PNP SILICON

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|-----------------------------|---------------|-------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | V(BR)CEO | 40 | _ | Vdc |
| Collector-Emitter Nonmatching Voltage (IC(on) = 600 mAdc, IB(on) = 120 mAdc, IB(off) = 0) | VCEO(NL)† | 40 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | V(BR)CBO | 60 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | Vdc |
| Base Cutoff Current (VCE = 50 Vdc, VBE(off) = 0.5 Vdc) | BEV | | 10 | nAdc |
| Collector Cutoff Current (VCE = 50 Vdc, VBE(off) = 0.5 Vdc) (VCE = 50 Vdc, VBE(off) = 0.5 Vdc, TA = 150°C) | ICEV | _ | 0.01 10 | μAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | ^l EBO | | 10 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 0.1 mAdc, V _{CE} = 10 Vdc) (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc)(1) (I _C = 150 mAdc, V _{CE} = 10 Vdc)(1) (I _C = 150 mAdc, V _{CE} = 1.0 Vdc)(1) | hFE | 35 50 75 100 50 | — — 300 | |
| Collector-Emitter Saturation Voltage(1) (I _C = 150 mAdc, I _B = 15 mAdc) | V _{CE(sat)} | _ | 0.4 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 150 mAdc, IB = 15 mAdc) | V _{BE(sat)} | 0.85 | 1.3 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (IC = 20 mAdc, VCE = 10 Vdc, f = 100 MHz) | fΤ | 200 | | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 140 kHz) | Cobo | _ | 8.0 | pF |
| Input Impedance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{ie} | 1.6 | 9.0 | kohms |
| Small-Signal Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{fe} | 60 | 300 | _ |
| Output Admittance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | hoe | | 50 | μmho |
| Noise Figure ($I_C = 100 \mu Adc$, $V_{CE} = 10 Vdc$, $R_S = 1.0 \text{ kohm}$, $f = 1.0 \text{ kHz}$) | NF | _ | 8.0 | dB |
| SWITCHING CHARACTERISTICS | | | | • |
| Delay Time (V _{CC} = 10 Vdc, V _{BE(off)} = 0 Vdc, | t _d | - | 10 | ns |
| Rise Time I _C = 150 mAdc, I _{B1} = 15 mAdc) | t _r | 1 | 40 | ns |
| Storage Time (V _{CC} = 10 Vdc, I _C = 150 mAdc, | ts | 1 | 250 | ns |
| Fall Time IB1 = IB2 = 15 mAdc) | tf | | 90 | กร |

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

[†] The highest value of collector supply voltage that may be safely used with a resistive load switching circuit in which the collector current is 600 mAdc.

2N4015 2N4016

CASE 654-07, STYLE 1

DUAL AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Va | lue | Unit | | |
|---|-----------------------------------|----------------------|-------------|----------------|--|------|
| Collector-Emitter Voltage | VCEO | e | Vdc | | | |
| Collector 1 to Collector 2 Voltage Voltage Rating and Lead to Case | V _{C1C2} | ±200 ±200 | | Vdc | | |
| Collector-Base Voltage | VCBO | 60 | | Vdc | | |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc | | |
| Base Current | lB . | 100 | | mAdc | | |
| Collector Current — Continuous | lC | 300 | | 300 | | mAdc |
| | | One Die | Both Die | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 400 2.29 | 500 2.86 | mW mW/℃ | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 0.85 1.4 4.85 8.0 | | Watts mW/°C | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | – 65 to | °C | | | |

Refer to MD2905,A for graphs.

| Characteristic | Symbol | Min | Max. | Unit |
|---|----------------------|-------------------------|----------|--------------|
| OFF CHARACTERISTICS | | | | • |
| Collector-Emitter Breakdown Voltage(1) (I _C = 10 mAdc, I _B = 0) | V(BR)CEO | 60 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 60 | | Vdc |
| Emitter-Base Breakdown Voltage (ig = 10 μAdc, ig = 0) | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) (VCB = 50 Vdc, IE = 0, TA = +150°C) | ICBO | = | 10 10 | nAdc µAdc |
| Emitter Cutoff Current (VEB = 3.0 Vdc, I _C = 0) | [[] EBO | _ | 0.1 | μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 0.01 mAdc, VCE = 5.0 Vdc) (IC = 0.1 mAdc, VCE = 5.0 Vdc) (IC = 1.0 mAdc, VCE = 5.0 Vdc) (IC = 50 mAdc, VCE = 5.0 Vdc) (IC = 50 mAdc, VCE = 5.0 Vdc)(1) | h _{FE} | 80 120 135 115 | - 350 | |
| Collector-Emitter Saturation Voltage(1) (IC = 50 mAdc, IB = 2.5 mAdc) | VCE(sat) | _ | 0.25 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 50 mAdc, VCE = 2.5 Vdc) | V _{BE(sat)} | _ | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | • |
| Current-Gain — Bandwidth Product(2) (I _C = 50 mAdc, V _{CE} = 20 Vdc, f = 100 MHz) (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 20 MHz) | fτ | 200 60 | 600 — | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | | 8.0 | pF |
| Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | C _{ibo} | - | 25 | ρF |
| Input Impedence (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{ie} | | 11.5 | kohms |
| Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{re} | - | 15 | X 10-4 |
| Small-Signal Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{fe} | 135 | 420 | _ |

2N4015, 2N4016

| Characteristic | Symbol | Min | Max | Unit |
|---|-----------------|-----|-----|-------|
| Output Admittance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{OB} | - | 80 | μmhos |
| Noise Figure (IC = 0.03 mAdc, V_{CE} = 5.0 Vdc, R_S = 10 kohms, f = 1.0 kHz, BW = 200 Hz) | NF | _ | 4.0 | dB |
| MATCHING CHARACTERISTICS | | | • | |

| DC Current Gain Ratio (I _C = 0.1 mAdc, V _{CE} = 5.0 Vdc) | | hFE1/hFE2 | 0.9 | 1.0 | - |
|--|------------------|---|-----|------------|------|
| Base-Emitter Voltage Differential (I _C = 0.1 to 1.0 mAdc, V _{CE} = 5.0 Vdc) | 2N4015 2N4016 | VBE1-VBE2 | _ | 5.0 2.5 | mVdc |
| Base-Emitter Voltage Differential Gradient (IC = 0.1 to 1.0 mAdc, VCE = 5.0 Vdc, TA = -55 to +25°C) | 2N4015 2N4016 | Δ(V _{BE1} -V _{BE2}) ΔΤ _Α | = | 1.6 0.8 | mVdc |
| $(I_C = 0.1 \text{ to } 1.0 \text{ mAdc, V}_{CE} = 5.0 \text{ Vdc, T}_A = +25^{\circ}\text{C to } +125^{\circ}\text{C})$ | 2N4015 2N4016 | | _ | 2.0 1.0 | |

Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 1.0%.
 † is defined as the frequency at which |hfe| extrapolates to unity.

2N4854 2N4855

2N4854 — JAN, JTX, JTXV AVAILABLE CASE 654-07, STYLE 5

COMPLEMENTARY DUAL AMPLIFIER TRANSISTOR

NPN/PNP SILICON

MAXIMUM RATINGS

| WAXIMON DATINGS | | | | |
|---|-----------------------------------|--------------|--------------|-------------|
| Rating | Symbol | Value | | Unit |
| Collector-Emitter Voltage | VCEO | 40 | | Vdc |
| Collector 1 to Collector 2 Voltage Voltage Rating any Lead to Case | VC1C2 | ±200 ±200 | | Vdc |
| Collector-Base Voltage | VCBO | 60 | | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc |
| Collector Current — Continuous | ũ | 600 | | mAdc |
| | | One Die | Both Die | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 2.0 | 600 4.0 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 6.67 | 2.0 13.33 | Watts |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | 65 to | °C | |

Refer to MD6001 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|------------------|----------------------|-----------|------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | | V(BR)CEO | 40 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | | V(BR)CBO | 60 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 50 Vdc, I _E = 0, T _A = 150°C) | | ІСВО | _ | 10 | μAdc |
| Emitter Cutoff Current (VEB = 3.0 Vdc, I _C = 0) | | IEBO | - | 10 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 0.1 mAdc, VCE = 10 Vdc) | 2N4854 2N4855 | pŁE | 35 20 | = | _ |
| (IC = 1.0 mAdc, V_{CE} = 10 Vdc) | 2N4854 2N4855 | | 50 25 | = | |
| (IC = 10 mAde, VCE = 10 Vde)(1) | 2N4854 2N4855 | | 75 35 | = | |
| $(I_C = 150 \text{ mAdc}, V_{CE} = 10 \text{ Vdc})(1)$ | 2N4854 2N4855 | | 100 40 | 300 120 | |
| (IC = 150 mAdc, VCE = 1.0 Vdc)(1) | 2N4854 2N4855 | | 50 20 | = | |
| (I _C = 300 mAdc, V _{CE} = 10 Vdc)(1) | 2N4854 2N4855 | | 35 20 | | |
| Collector-Emitter Saturation Voltage(1) (IC = 150 mAdc, IB = 15 mAdc) | | V _{CE(sat)} | _ | 0.4 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 150 mAdc, IB = 15 mAdc) | | V _{BE(sat)} | 0.75 | 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (I _C = 20 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | | fT | 200 | _ | MHz |

280

70

ns

ns

2N4854, 2N4855

Storage Time

Fall Time

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)

| Characteristic | | Symbol | Min | Max | Unit |
|---|------------------|-----------------|-------------|------------|-------|
| Collector-Base Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | | C _{cb} | _ | 8.0 | pF |
| Input Impedance (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | 2N4854 2N4855 | h _{ie} | 1.5 0.75 | 9.0 4.5 | kohms |
| Small-Signal Current Gain (IC = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | 2N4854 2N4855 | h _{fe} | 60 30 | 300 150 | _ |
| Output Admittance (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | 2N4854 2N4855 | h _{oe} | | 50 25 | μmhos |
| Noise Figure (IC = 100 \(\mu \text{Adc}, \text{VCE} = 10 \text{ Vdc, Rs} = 1.0 \text{ kohm, f} : | = 1.0 kHz) | NF | - | 8.0 | dB |
| SWITCHING CHARACTERISTICS | | | | | |
| Delay Time (VCC = 30 Vdc, VBE(off) | = 0.5 Vdc, | ^t d | _ | 20 | ns |
| Rise Time 1C = 150 mAdc, 181 = 15 | | tr | - | 40 | ns |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

2N4937 thru 2N4942

2N4937, 2N4938, 2N4939 CASE 654-07, STYLE 1 2N4440, 2N4441, 2N4442 CASE 610A-04, STYLE 1

DUAL AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| MAXIMUM RATINGS | | | | | | |
|--|-------------------|--------------------------|--------------------------|----------------|--|------|
| Rating | Symbol | Va | lue | Unit | | |
| Collector-Emitter Voltage | VCEO | 4 | 40 | | | |
| Collector 1 to Collector 2 Voltage Voltage Rating and Lead to Case | V _{C1C2} | ± 200 ± 200 | | | | Vdc |
| Collector-Base Voltage | VCBO | 5 | 50 | | | |
| Emitter-Base Voltage | VEBO | 5.0 | | 5.0 | | Vdc |
| Base Current | 1 _B | 10 | | 10 | | mAdc |
| Collector Current — Continuous | lc | 50 | | 50 | | mAdc |
| | | One Die | Both Die | | | |
| Total Device Dissipation @ T _A = 25°C — Ceramic Metal Can Derate above 25°C — Ceramic Metal Can | PD | 250 500 1.5 2.9 | 350 600 2.0 3.4 | mW mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C Metal Can | PD | 1.2 6.85 | 2.0 11.42 | Watts mW/°C | | |
| Operating and Storage Junction Temperature Range | TJ, Tstg | -65 to | + 200 | °C | | |

Refer to MD3250,A for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|-----------------|----------------|-------------------|--------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 10 mAdc, IB = 0) | V(BR)CEO | 40 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 µAdc, I _E = 0) | V(BR)CBO | 50 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 40 Vdc, IE = 0) | Ісво | _ | 20 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | IEBO | _ | 20 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 100 µAdc, V _{CE} = 10 Vdc) (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc) | hFE | 40 50 50 | 200 250 250 | _ |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 100 Mhz) | fΤ | 300 | 900 | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 140 kHz) Emitter Guarded | C _{cb} | _ | 5.0 | pF |
| Input Impedance (IBE = 0.5 Vdc, IC = 0, f = 140 kHz) Collector Guarded | C _{eb} | _ | 10 | ρF |
| Input Impedance (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{ie} | 1.0 | 10 | kΩ |
| Voltage Feedback Ratio (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{re} | _ | 10 | X 10-4 |
| Small-Signal Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 kHz) | h _{fe} | 50 | - | _ |
| Output Admittance (IC = 1.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | h _{oe} | 5.0 | 50 | μmhos |
| Noise Figure (I _C = 100 μ Adc, V _{CE} = 10 Vdc, R _S = 3.0 k Ω , f = 10 Hz to 15.7 kHz) | NF | _ | 4.0 | d₿ |

2N4937 thru 2N4942

| Characteristic | | Symbol | Min | Max | Unit |
|--|----------------|--------------|------|-----|------|
| MATCHING CHARACTERISTICS | | | | • | • |
| DC Current Gain Ratio(1) | | hFE1/hFE2 | | | |
| (IC = 100 μ Adc to 1.0 mAdc, VCE = 10 Vdc) | 2N4937, 2N4941 | | 0.9 | 1.0 | |
| - | 2N4938, 2N4940 | | 0.8 | 1.0 | |
| (IC = 100 μ Adc to 1.0 mAdc, VCE = 10 Vdc, | | | | | } |
| $T_A = -55^{\circ}C \text{ to } 125^{\circ}C)$ | 2N4937, 2N4941 | | 0.85 | 1.0 | [|
| | 2N4938, 2N4940 | | 0.7 | 1.0 | |
| Base-Emitter Voltage Differential | | VBE1-VBE2 | | | mVdc |
| (I _C = 100 μ Adc to 1.0 mAdc, V _{CE} = 10 Vdc) | 2N4937, 2N4941 | | _ | 3.0 | |
| | 2N4938, 2N4940 | | _ | 5.0 | |
| Base-Emitter Voltage Differential Gradient | | Δ(VBE1-VBE2) | | | mVdc |
| (IC = 100 μ Adc to 1.0 mAdc, VCE = 10 Vdc, | | ΔΤΔ | | 1.0 | |
| T _A = 25°C to +125°C) | 2N4937, 2N4941 | | _ | 2.0 | |
| | 2N4938, 2N4940 | | _ | | |
| (IC = 100 µAdc to 1.0 mAdc, VCE = 10 Vdc, | | | | 0.8 | |
| $T_A = -55^{\circ}C$ to 25°C) | 2N4937, 2N4941 | | _ | 1.6 | |
| •• | 2N4938, 2N4940 | | _ | | |

⁽¹⁾ The lowest hee reading is taken as hee1 for this ratio.

2N5793 2N5794

JAN, JTX, JTXV AVAILABLE CASE 654-07, STYLE 1

DUAL TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MAXIMON DATINGS | | | | | | |
|---|-----------------------------------|-------------|----------------------------|----------------|--|------|
| Rating | Symbol | V | alue | Unit | | |
| Collector-Emitter Voltage | VCEO | | 40 | Vdc | | |
| Collector-Base Voltage | VCBO | | 75 | | | |
| Emitter-Base Voltage | VEBO | 6.0 | | Vdc | | |
| Collector Current — Continuous | 1 _C | 600 | | 600 | | mAdc |
| | | One Die | Both Die Equal Power | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 500 2.9 | 600 3.4 | mW mW/℃ | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 6.9 | 2.0 11.43 | Watts mW/°C | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | ů | | |

Refer to MD2218,A for graphs.

| Characteristic | | Min | Max | Unit |
|--|----------------------|---|------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | | 40 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 μAdc, IE = 0) | V(BR)CBO | 75 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 μAdc, IC = 0) | V(BR)EBO | 6.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) | ICBO | _ | 10 | nAdc |
| Emitter Cutoff Current (VEB = 4.0 Vdc, IC = 0) | IEBO | _ | 10 | nAdc |
| Collector 1 to Collector 2 Leakage Current (V1C-2C = ± 50 Vdc) | lC1-C2 | _ | ±1.0 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 100 μ Adc, VCE = 10 Vdc) 2N5793 2N5794 (IC = 1.0 mAdc, VCE = 10 Vdc) 2N5793 2N5794 (IC = 10 mAdc, VCE = 10 Vdc)(1) 2N5793 2N5794 (IC = 150 mAdc, VCE = 1.0 Vdc)(1) 2N5793 2N5794 (IC = 150 mAdc, VCE = 1.0 Vdc)(1) 2N5793 2N5794 (IC = 150 mAdc, VCE = 10 Vdc)(1) 2N5793 2N5794 (IC = 300 mAdc, VCE = 10 Vdc)(1) 2N5793 2N5794 | hFE | 20 35 25 50 35 75 20 50 40 100 25 | | - |
| Collector-Emitter Saturation Voltage(1) (I _C = 150 mAdc, I _B = 15 mAdc) (I _C = 300 mAdc, I _B = 30 mAdc) | VCE(sat) | | 0.3 0.9 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 150 mAdc, IB = 15 mAdc) (IC = 300 mAdc, IB = 30 mAdc) | V _{BE(sat)} | 0.6 | 1.2 1.8 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | <u>,</u> | | | |
| Current-Gain — Bandwidth Product(2) (IC = 20 mAdc, VCE = 20 Vdc, f = 100 MHz) | ĺΤ | 250 | | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | C _{cb} | | 8.0 | pF |
| Emitter-Base Capacitance (VEB = 0.5 Vdc, IC = 0, f = 100 kHz) | Ceb | | 25 | pF |
| SWITCHING CHARACTERISTICS | , | | | |
| Delay Time (VCC = 30 Vdc, VBE(off) = 0.5 Vdc, | td | _ | 15 | ns |
| Rise Time IC = 150 mAdc, IB1 = 15 mAdc) | t _r | _ | 30 | ns |
| Storage Time (VCC = 30 Vdc, IC = 150 mAdc, | t _S | - | 250 | ns |
| Fall Time IB1 = IB2 = 15 mAdc) | tf | | 60 | ns |

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

⁽²⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.

MAXIMUM RATINGS

| Rating | Symbol | Value | | Unit | | |
|---|----------------------|-------------|----------------------------|----------------|--|------|
| Collector-Emitter Voltage | VCEO | 60 | | Vdc | | |
| Collector-Base Voltage | V _{CBO} | | 60 | Vdc | | |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc | | |
| Collector Current — Continuous | lc | 600 | | 600 | | mAdc |
| | | One Die | Both Die Equal Power | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 500 2.9 | 600 3.4 | mW/°C | | |
| Total Power Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 6.9 | 2.0 11.43 | Watts mW/°C | | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | | င့ | | |

2N5795 2N5796

JAN, JTX, JTXV AVAILABLE CASE 654-07, STYLE 1

DUAL TRANSISTOR

PNP SILICON

Refer to MD2904,A for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|----------------------|----------------------|---|-------------------|----------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | | V(BR)CEO | 60 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 μAdc, IE = 0) | | V(BR)CBO | 60 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) | · | lCBO | _ | 20 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | | I _{EBO} | _ | 100 | nAdc |
| Collector 1 to Collector 2 Leakage Current (V1C-2C = ±50 V | /dc | ¹ C1-C2 | _ | ±1.0 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 100 \(\text{µAdc}, \text{ VCE} = 10 \text{ Vdc} \) (IC = 1.0 mAdc, \(\text{ VCE} = 10 \text{ Vdc} \) (IC = 10 mAdc, \(\text{ VCE} = 10 \text{ Vdc} \)(1) (IC = 150 mAdc, \(\text{ VCE} = 1.0 \text{ Vdc} \)(1) (IC = 150 mAdc, \(\text{ VCE} = 10 \text{ Vdc} \)(1) (IC = 500 mAdc, \(\text{ VCE} = 10 \text{ Vdc} \)(1) Collector-Emitter Saturation Voltage(1) (IC = 150 mAdc, IB = 10 mA | | hFE VCE(sat) | 40 75 40 100 40 100 50 40 100 40 50 | | Vdc |
| (I _C = 500 mAdc, I _B : Base-Emitter Saturation Voltage(1) (I _C = 150 mAdc, I _B = 15 (I _C = 500 mAdc, I _B = 50 mAdc | mAdc) | V _{BE(sat)} | _ | 1.6 1.3 2.6 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product(2) (IC = 50 mAdc, VCE = | 20 Vdc, f = 100 MHz) | fŢ | 200 | | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, IE = 0, f = 100 | kHz) | C _{cb} | | 8.0 | pF |
| Emitter-Base Capacitance (VEB = 2.0 Vdc, IC = 0, f = 100 kHz) | | Ceb | | 30 | рF |
| SWITCHING CHARACTERISTICS (See Figure 1) | | | | | <u> </u> |
| Delay Time (VCC = 30 Vdc, VBE(off) = 0.5 Vd | lc, | td | | 12 | ns |
| Rise Time IC = 150 mAdc, IB1 = 15 mAdc) | | t _r | | 35 | ns |
| Storage Time (VCC = 30 Vdc, IC = 150 mAdc, | | ts | - | 100 | ns |
| Fall Time $I_{B1} = I_{B2} = 15 \text{ mAdc}$ | | tf | | 40 | ns |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

⁽²⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.

2N6501 2N6502 2N6503

QUAD CERAMIC 2N6501 CASE 607,04, STYLE 1

DUAL 2N6502 CASE 654-07, STYLE 1

DUAL CERAMIC 2N6503 CASE 610A-04, STYLE 1

SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MAXIMUM KATINGS | | | | | | |
|---|-----------------------------------|---------|---------------------|-------|--|-----|
| Rating | Symbol | Va | lue | Unit | | |
| Collector-Emitter Voltage | VCEO | | 10 | Vdc | | |
| Collector-Base Voltage | VCES | | 30 | Vdc | | |
| Collector-Base Voltage | V _{CBO} | | 30 | Vdc | | |
| Emitter-Base Voltage | VEBO | 6.0 | | Vdc | | |
| Collector Current — Continuous | lc | 1.0 | | 1.0 | | Adc |
| | | One Die | One Die Equal Power | | | |
| Total Device Dissipation @ TA = 25°C | PD | | | mW | | |
| 2N6502 | | 600 | 650 | | | |
| 2N6503 | | 350 | 400 | | | |
| 2N6501 | | 400 | 600 | | | |
| Derate above 25°C | 1 1 | | | mW/°C | | |
| 2N6502 | | 3.42 | 3.7 | 1 | | |
| 2N6503 | | 2.0 | 2.28 | | | |
| 2N6501 | | 2.28 | 3.42 | ľ | | |
| Total Device Dissipation @ TC = 25°C | PD | | | Watts | | |
| 2N6502 | 1 | 2.1 | 3.0 | | | |
| 2N6503 | | 1.25 | 2.5 | | | |
| 2N6501 | | 1.0 | 4.0 | | | |
| Derate above 25°C | | | 1 | mW/℃ | | |
| 2N6502 | | 12 | 17.2 | | | |
| 2N6503 | | 7.15 | 14.3 | | | |
| 2N6501 | | 5.71 | 22.8 | | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 65 t | o +200 | °C | | |

THERMAL CHARACTERISTICS

| Characteristic | | Symbol | One Die | All Die Equal Power | Unit |
|--|---------------|-----------|------------------------|------------------------|------|
| Thermal Resistance, Junction to Case | | Resc | | | °C/W |
| · | 2N6502 | | 83.3 | 58.3 | |
| | 2N6503 | | 140 | 70 | |
| | 2N6501 | | 175 | 43.8 | |
| Thermal Resistance, Junction to Ambient(1) | | Raja | | | °C/W |
| | 2N6502 | "" | 292 | 270 | |
| | 2N6503 | | 500 | 438 | |
| | 2N6501 | | 438 | 292 | |
| | | | Junction to Ambient | Junction to Case | |
| Coupling Factor | | | | | |
| • • | 2N6502 | | 85 | 40 | |
| | 2N6503 | | 75 | 0 | |
| | 2N6501 (Q1, Q | 2) | 57 | 0 | |
| | (Q1-Q3 |), Q1-Q4) | 56 | 0 | |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

| Characteristic | Symbol | Min | Max | Unit |
|--|----------|-----|-----|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, Ig = 0) | V(BR)CEO | 40 | _ | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 100 µAdc, VBE = 0) | V(BR)CES | 80 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 80 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 6.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 40 Vdc, IE = 0) | ІСВО | _ | 1.7 | μAdc |

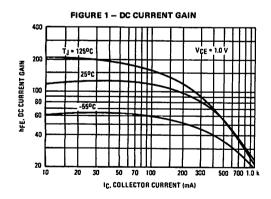
2N6501, 2N6502, 2N6503

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|----------------|------------|------|
| Emitter Cutoff Current (VBE = 4.0 Vdc, IC = 0) | IEBO | _ | 1.0 | μAdc |
| ON CHARACTERISTICS | | · | 1 | L |
| DC Current Gain (I _C = 100 mAdc, V _{CE} = 1.0 Vdc) (I _C = 500 mAdc, V _{CE} = 2.0 Vdc) (I _C = 500 mAdc, V _{CE} = 1.0 Vdc) | hFE | 50 30 10 | 150 — | _ |
| Collector-Emitter Saturation Voltage (I _C = 100 mAdc, I _B = 10 mAdc) (I _C = 500 mAdc, I _B = 50 mAdc) | VCE(sat) | 11 | 0.3 0.5 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 500 mAdc, I _B = 50 mAdc) | V _{BE(sat)} | 0.8 | 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (I _C = 50 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | fT | 250 | _ | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | C _{cb} | _ | 10 | pF |
| Emitter-Base Capacitance (VBE = 0.5 Vdc , IC = 0 , f = 100 kHz) | C _{eb} | _ | 65 | pF |
| SWITCHING CHARACTERISTICS | | | | |
| Turn-On Time (V _{CC} = 30 Vdc, V_{BE} = 3.8 Vdc, I_C = 500 mAdc, I_{B1} = 50 mAdc) | ton | | 35 | ns |
| Turn-Off Time (V _{CC} = 30 Vdc, I_C = 500 mAdc, I_{B1} = I_{B2} = 50 mAdc) | toff | | 60 | ns |

(2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

TYPICAL DC CHARACTERISTICS



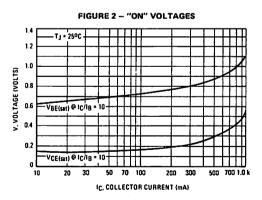
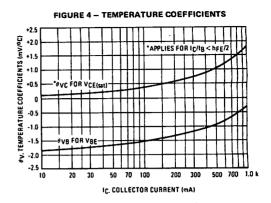
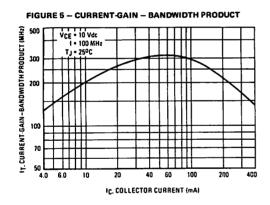
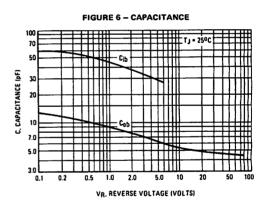


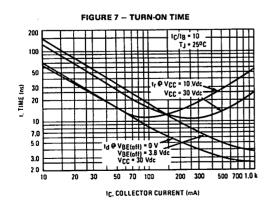
FIGURE 3 - COLLECTOR SATURATION REGION VCE, COLLECTOR-EMITTER VOLTAGE (VOLTS) TJ - 25°C 0.6 0.4 500 m 0.5 1.0 2.0 10 20 60 100 200 500 IB. BASE CURRENT (mA)

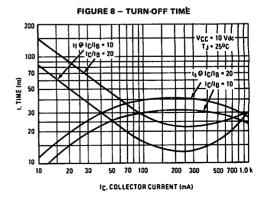


TYPICAL DYNAMIC CHARACTERISTICS



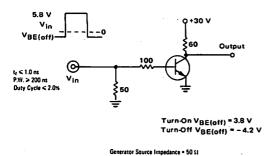


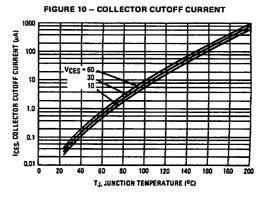




2N6501, 2N6502, 2N6503

FIGURE 9 - SWITCHING TIME TEST CIRCUIT





MD708,A,B

CASE 654-07, STYLE 1

MD708F,AF,BF

CASE 610A-04, STYLE 1

DUAL AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MD2369 for graphs.

MAXIMUM RATINGS

| Symbol | Va | lue | Unit |
|-----------------------------------|-----------------------|---|--|
| VCEO | 1 | 5 | Vdc |
| VCBO | 4 | Ö | Vdc |
| VEBO | 5 | .0 | Vdc |
| lc | 2 | 00 | mAdc |
| | One Die | Both Die Equal Power | |
| PD | | | mW |
| | 550 350 | 600 400 | mW/°C |
| | 3.13 2.0 | 3.42 2.28 | |
| PD | _ | | Watts |
| | 1.4 0.7 | 2.0 1.4 | mW/°C |
| | 8.0 4.0 | 11.4 8.0 | |
| T _J , T _{stg} | - 65 t | °C | |
| | VCEO VCBO VEBO IC PD | VCEO 1 VCBO 4 VEBO 5 IC 2 One Die PD 550 350 3.13 2.0 PD 1.4 0.7 8.0 4.0 | VCEO 15 VCBO 40 VEBO 5.0 IC 200 Both Die Equal Power PD 550 600 350 400 3.13 3.42 2.0 2.28 PD 1.4 2.0 0.7 1.4 8.0 11.4 4.0 8.0 |

THERMAL CHARACTERISTICS

| Cheracteristic | Symbol | One Die | Both Die Equal Power | Unit |
|---|----------------------|------------------------|-------------------------|------|
| Thermal Resistance, Junction to Case MD708, MD708A, MD708B MD708F, MD708AF, MD708BF | R _{ØJC} | 125 250 | 87.5 125 | *C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 319 500 | 292 438 | °C/W |
| | | Junction to Ambient | Junction to Case | |
| Coupling Factors MD708, MD708A, MD708B MD708F, MD708AF, MD708BF | | 83 75 | 40 0 | % |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|----------------------|----------------------|--------------|
| OFF CHARACTERISTICS | | | _ | _ |
| Collector-Emitter Breakdown Voltage(2) (IC = 30 mAdc, IB = 0) | V(BR)CEO | 15 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 40 | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 20 Vdc, IE = 0) (VCB = 20 Vdc, IE = 0, TA = 150°C) | l _{CBO} | _ | 15 30 | nAdc μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain(2) (IC = 500 µAdc, VCE = 1.0 Vdc) (IC = 10 mAdc, VCE = 1.0 Vdc) (IC = 100 mAdc, VCE = 5.0 Vdc) (IC = 150 mAdc, VCE = 5.0 Vdc) | pEE | 40 40 35 20 | 200 — | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc) (I _C = 100 mAdc, I _B = 10 mAdc) | VCE(sat) | | 0.20 0.35 0.50 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) (IC = 50 mAdc, IB = 5.0 mAdc) (IC = 100 mAdc, IB = 10 mAdc) | V _{BE(sat)} | 0.65 — | 0.85 0.95 1.10 | Vdc |

⁽²⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MAXIMUM RATINGS

| MAXIMUM RATINGS | | | | |
|---|-----------------------------------|---------------------------|----------------------------|----------------|
| Rating | Symbol | Value | | Unit |
| Collector-Emitter Voltage | VCEO | 1 | 5 | Vdc |
| Collector-Base Voltage | V _{CBO} | 3 | 10 | Vdc |
| Emitter-Base Voltage | VEBO | 3 | .0 | Vdc |
| Collector Current — Continuous | lc | 5 | i0 | mAdc |
| | | One Die | Both Die | |
| Total Device Dissipation @ T _A = 25°C MD918,A,B MD918F,AF,BF Derate above 25°C MD918,A,B MD918F,AF,BF | PD | 550 350 3.14 2.0 | 600 400 3.42 2.28 | mW/°C |
| Total Device Dissipation @ T _C = 25°C MD918,A,B MD918F,AF,BF Derate above 25°C MD918,A,B MD918F,AF,BF | PD | 1.4 0.7 8.0 4.0 | 2.0 1.4 11.4 8.0 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | °C |

MD918A MD918B

CASE 654-07, STYLE 1

MD918F MD918AF MD918BF

CASE 610A-04, STYLE 1

DUAL

AMPLIFIER TRANSISTOR

NPN SILICON

THERMAL CHARACTERISTICS

| Characteristic | | Symbol | One Die | All Die Equal Power | Unit |
|---|---------------------------|----------------------|------------------------|------------------------|------|
| Thermal Resistance, Junction to Case | MD918,A,B MD918F,AF,BF | RAJC | 125 250 | 87.5 125 | °C/W |
| Thermal Resistance, Junction to Ambient | MD918,A,B MD918F,AF,BF | R _{ØJA} (1) | 319 500 | 292 438 | °C/W |
| | | | Junction to Ambient | Junction to Case | |
| Coupling Factors | MD918,A,B MD918F,AF,BF | | 83 75 | 40 0 | . % |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------------------|-----|-------------|---------------------------------------|--------------|
| OFF CHARACTERISTICS | | | | | - |
| Collector-Emitter Breakdown Voltage(2) (IC = 3.0 mAdc, I _B = 0) | V(BR)CEO | 15 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 1.0 μ Adc, I _E = 0) | V(BR)CBO | 30 | _ | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | V(BR)EBO | 3.0 | | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 15 Vdc, I _E = 0) (V _{CB} = 15 Vdc, I _E = 0, T _A = 150°C) | ІСВО | _ | _ | 10 1.0 | nAdc μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 3.0 mAdc, V _{CE} = 5.0 Vdc) | pkE | 50 | 165 | _ | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 Adc) | VCE(sat) | _ | 0.09 | 0.2 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | V _{BE(sat)} | _ | 0.86 | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | · · · · · · · · · · · · · · · · · · · | |
| Current-Gain — Bandwidth Product (IC = 4.0 mAdc, VCE = 10 Vdc, f = 100 MHz) | fT | 600 | _ | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | | 1.1 | 1.7 | pF |

MD918,A,B,F,AF,BF

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|------------------|-----|------|-----|------|
| Input Capacitance (VgE = 0.5 Vdc, I _C = 0, f = 100 kHz) | C _{ibo} | _ | 1.15 | 2.0 | pF |
| Noise Figure (IC = 1.0 mAdc, VCE = 6.0 Vdc, RS = 400Ω, f = 60 MHz) | NF | _ | _ | 6.0 | dB |

MATCHING CHARACTERISTICS

| DC Current Gain Ratio(3) | | hFE1/hFE2 | | | | _ |
|---|--------------|--------------|-----|-----|-----|-------|
| (IC = 1.0 mAdc, $V_{CE} = 5.0 \text{ Vdc}$) | MD9188,BF | | 0.8 | _ | 1.0 | |
| | MD918A,AF | | 0.9 | _ | 1.0 | |
| Base-Emitter Voltage Differential | | VBE1-VBE2 | | | | mVdc |
| (IC = 1.0 mAdc, VCF = 5.0 Vdc) | MD918B.BF | , 52, 555 | _ | _ | 10 | |
| 11C 11C 11C 11C 11C 11C | MD918A,AF | | _ | _ | 5.0 | |
| Base-Emitter Voltage Differential Gradient | | Δ(VBE1-VBE2) | | | | |
| (IC = 1.0 mAdc, VCE = 5.0 Vdc, | MD918B,AF,BF | ΔΤΑ | l — | - ' | 20 | μV/dc |
| $T_A = -55 \text{ to } + 125^{\circ}\text{C}$ | MD918A | | _ | _ | 10 | °C |

- (2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.
- (3) The lowest hee reading is taken as hee1 for this ratio.

FIGURE 1 - DC CURRENT GAIN

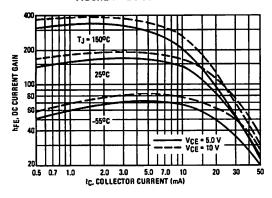
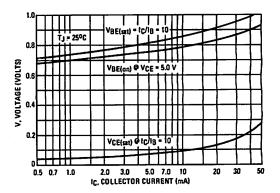
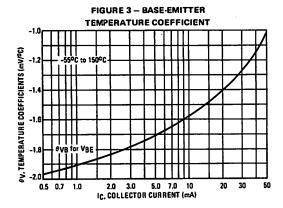
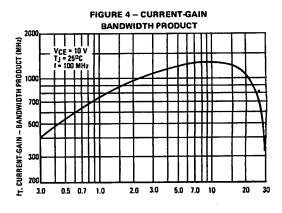
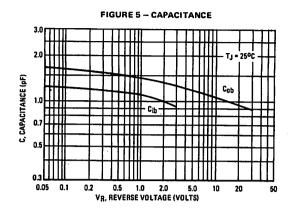


FIGURE 2 - "ON" VOLTAGES









MD982,F MQ982

MD982 CASE 654-07, STYLE 1

MD982F CASE 610A-04, STYLE 1

MQ982 CASE 607-04, STYLE 1

DUAL AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| MAXIMUM RATINGS | | | | |
|---|----------------------|---------|---------|-------|
| Rating | Symbol | Val | ue | Unit |
| Collector-Emitter Voltage | VCEO | 5 | 50 | |
| Collector-Base Voltage | VCBO | 6 | 0 | Vdc |
| Emitter-Base Voltage | VEBO | 5 | .0 | Vdc |
| Collector Current — Continuous | lc | 60 | 00 | mAdc |
| | • | One Die | All Die | |
| Total Device Dissipation @ T _A = 25℃ | PD | | | mW |
| MD982 | - | 600 | 650 | } |
| MD982F | Į . | 350 | 400 | l |
| MQ982 | | 400 | 600 | ì |
| Derate above 25°C | | | | mW/°C |
| MD982 | | 3.42 | 3.7 | ĺ |
| MD982F | | 2.0 | 2.28 | 1 |
| MQ982 | | 2.28 | 3.42 | |
| Total Device Dissipation @ T _C = 25°C | PD | | | Watts |
| MD982 | ł | 2.1 | 3.8 | |
| MD982F | İ | 1.25 | 2.5 | |
| MQ982 | 1 | 1.0 | 4.0 | l |
| Derate above 25°C | 1 | 1 | | mW/°C |
| MD982 | | 12 | 17.2 | 1 |
| MD982F | | 7.15 | 14.3 | 1 |
| MQ982 | | 5.71 | 22.8 | |
| Operating and Storage Junction Temperature Range | Tj, T _{stg} | - 65 to | + 200 | ℃ |

THERMAL CHARACTERISTICS

| Characteristic | | Symbol | One Die | All Die Equal Power | Unit |
|---|--------------------------|-----------------------------|------------------------|------------------------|------|
| Thermal Resistance, Junction to Case | MD982 MD982F MQ982 | RAIC | 83.3 140 175 | 58.3 70 43.8 | °C/W |
| Thermal Resistance, Junction to Ambient | MD982 MD982F MQ982 | R _{ØJA} (1) | 292 500 438 | 270 438 292 | °C⁄W |
| | | | Junction to Ambient | Junction to Case | |
| Coupling Factor | MD982 MD982F MQ982 | (Q1-Q2) (Q1-Q3 or Q1-Q4) | 85 75 57 55 | 40 0 0 | % |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

| Symbol | Min | Тур | Max | Unit |
|----------------------|---|---|---|---|
| | | | | |
| V(BR)CEO | 50 | - | | Vdc |
| V(BR)CBO | 60 | | _ | Vdc |
| V(BR)EBO | 5.0 | | | Vdc |
| ſСВО | _ | _ | 0.020 20 | μAdc |
| | | | | |
| pŁE | 20 25 35 40 | 50 75 90 60 | _ _ _ | - |
| V _{CE(sat)} | _ | 0.25 | 0.5 | Vdc |
| V _{BE(sat)} | | 0.88 | 1.4 | Vdc |
| | | | | |
| fτ | 200 | 320 | | MHz |
| Cobo | - | 5.8 | 8.0 | pF |
| Cibo | | 16 | 30 | pF |
| | V(BR)CEO V(BR)CBO V(BR)EBO ICBO hFE VCE(sat) VBE(sat) | V(BR)CEO 50 V(BR)CBO 60 V(BR)EBO 5.0 ICBO — hFE 20 25 35 40 VCE(sat) — VBE(sat) — | V(BR)CEO 50 — V(BR)CBO 60 — V(BR)EBO 5.0 — ICBO — — hFE 20 50 25 75 35 90 40 60 VCE(sat) — 0.25 VBE(sat) — 0.88 | V(BR)CEO 50 V(BR)CBO 60 V(BR)EBO 5.0 ICBO 20 hFE 20 50 25 75 35 90 40 60 VCE(sat) 0.88 1.4 fT 200 320 |

MAXIMUM RATINGS

| Rating | Symbol | v | Value | | | |
|---|----------------------|-------------|-------------------------|----------------|--|------|
| Collector-Emitter Voltage | VCEO | | 20 | | | |
| Collector-Base Voltage | VCBO | | 40 | Vdc | | |
| Emitter-Base Voltage | VEBO | | 5.0 | Vdc | | |
| Collector Current — Continuous | lc | 200 | | 200 | | mAdc |
| | | One Die | Both Die Equal Power | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 575 3.29 | 625 3.57 | mW mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.8 10.3 | 2.5 14.3 | Watts mW/°C | | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | - 65 1 | °C | | | |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | One Die | Both Die Equal Power | Unit |
|--|----------------------|------------------------|-------------------------|------|
| Thermal Resistance, Junction to Case | R _Ø JC | 97 | 70 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{EJA} (1) | 304 | 280 | °C/W |
| | | Junction to Ambient | Junction to Case | |
| Coupling Factor | | 84 | 44 | |

MD984

CASE 654-07, STYLE 1

DUAL

AMPLIFIER TRANSISTOR

PNP SILICON

Refer to MD3250 for graphs.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|----------------------|-----|---------------------------------------|------------|--------------|
| OFF CHARACTERISTICS | | | • | - | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, IB = 0) | V(BR)CEO | 20 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 µAdc, I _E = 0) | V(BR)CBO | 40 | <u> </u> | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 20 Vdc, IE = 0) (VCB = 20 Vdc, IE = 0, TA = 150°C) | ІСВО | _ | _ | 25 30 | nAdc μAdc |
| ON CHARACTERISTICS | | | | • | |
| DC Current Gain(2) (IC = 10 mAde, VCE = 10 Vdc) | hFE | 25 | 75 | _ | |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 5.0 mAdc)(2) | VCE(sat) | = | 0.18 0.38 | 0.3 0.5 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | V _{BE(sat)} | _ | 0.8 | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | · · · · · · · · · · · · · · · · · · · | • | |
| Current-Gain — Bandwidth Product(2) (I _C = 20 mAdc, V _{CF} = 20 Vdc, f = 100 MHz) | fī | 250 | 550 | _ | MHz |

⁽²⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

MD985,F

MD985 CASE 654-07, STYLE 5

MD985F CASE 610A-04, STYLE 1

COMPLEMENTARY DUAL GENERAL PURPOSE TRANSISTOR

NPN/PNP SILICON

MAXIMUM RATINGS

| MAXIMUM RATINGS | | | | |
|---|----------------------|-------------|-------------------------|--------|
| Rating | Symbol | Va | lue | Unit |
| Collector-Emitter Voltage | VCEO | 3 | 30 | Vdc |
| Collector-Base Voltage | VCBO | € | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc |
| Collector Current — Continuous | lc | 5 | 00 | mAdc |
| | | One Die | Both Die Equal Power | |
| Total Device Dissipation @ TA = 25°C | PD | | | mW |
| MD985 | | 575 | 625 | |
| MD985F | | 350 | 400 | mW/°C |
| Derate above 25°C MD985 MD985F | | 3.29 2.0 | 3.57 2.28 | mvv/°C |
| Total Device Dissipation @ Tc = 25°C | PD | | | Watts |
| MD985 | | 1.8 | 2.5 | |
| MD985F | | 1.0 | 2.0 | |
| Derate above 25°C | | | 1 | mW/°C |
| MD985 | | 10.3 | 14.3 | 1 |
| MD985F | | 5.71 | 11.4 | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | - 65 te | o +200 | |

THERMAL CHARACTERISTICS

| Characteristic | | Symbol | One Die | Both Die Equal Power | Unit |
|---|-----------------|----------------------|------------------------|-------------------------|------|
| Thermal Resistance, Junction to Case | MD985 MD985F | R _{ØJC} | 97 175 | 70 87.5 | °C/W |
| Thermal Resistance, Junction to Ambient | MD985 MD985F | R _{6JA} (1) | 304 500 | 280 438 | °C/W |
| | | | Junction to Ambient | Junction to Case | |
| Coupling Factor | MD985 MD985F | · - · · · | 84 75 | 44 0 | % |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------|----------------------|----------------------|-------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, IB = 0) | V(BR)CEO | 30 | | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 60 | _ | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) (VCB = 50 Vdc, IE = 0, TA = +150°C) | ICBO | = | = | 20 20 | nAdc µAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 0.1 mAdc, V _{CE} = 10 Vdc) (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc) (I _C = 150 mAdc, V _{CE} = 10 Vdc) | hFE | 20 25 35 40 | 50 75 90 90 | _ _ _ | _ |
| Collector-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc) | VCE(sat) | _ | 0.3 | 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) | VBE(sat) | _ | 1.0 | 1.4 | Vdc |

MD985,F

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|------------------|-----|-----|-----|-------------|
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 20 Vdc, f = 100 MHz) MD985 | fτ | 200 | 320 | | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 100 kHz) | Copo | _ | 5.8 | 8.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = 0, f = 100 kHz) | C _{ibo} | _ | 20 | _ | pF |
| SWITCHING CHARACTERISTICS | - | * | | • | |
| Turn-On Time (V _{CC} = 30 Vdc, I _C = 150 mAdc, I _{B1} = 15 mAdc) | ton | - | 25 | | ns |
| Turn-Off Time ($V_{CC} = 30 \text{ Vdc}$, $I_{C} = 150 \text{ mAdc}$, $I_{B1} = I_{B2} = 15 \text{ mAdc}$) | toff | _ | 75 | | ns |

⁽²⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MD986,F

MD986 CASE 654-07, STYLE 5

MD986F CASE 610A-04, STYLE 1

COMPLEMENTARY DUAL
GENERAL PURPOSE TRANSISTOR

NPN/PNP SILICON

MAXIMUM RATINGS

| MAXIMUM RATINGS | | | | |
|---|------------------------------|------------|-------------|--------|
| Rating | Symbol | Va | lue | Unit |
| Collector-Emitter Voltage | VCEO | 1 | Vdc | |
| Collector-Base Voltage | VCBO | - | 10 | Vdc |
| Emitter-Base Voltage | VEBO | 9 | Vdc | |
| Collector Current — Continuous | lc | 2 | 00 | mAdc |
| | One Die Both Die Equal Power | | | |
| Total Device Dissipation @ TA = 25°C | PD | | | mW |
| MD986 | | 550 | 600 | |
| MD986F Derate above 25°C | i 1 | 350 | 400 | mW/°C |
| MD986 | | 3.14 | 3.42 | mvv/·C |
| MD986F | | 2.0 | 2.28 | |
| Total Device Dissipation @ T _C = 25°C | PD | | | Watts |
| MD986 | 1 | 1.4 | 2.0 | |
| MD986F | 1 1 | 0.7 | 1.4 | |
| Derate above 25°C | - - | | 1 | mW/°C |
| MD986 MD986F | 1 1 | 8.0 4.0 | 11.4 8.0 | |
| | | *** | | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | – 65 to | o +200 | ℃ |

THERMAL CHARACTERISTICS

| Characteristic | | Symbol | One Die | Both Die Equal Power | Unit |
|---|-----------------|----------------------|------------------------|-------------------------|------|
| Thermal Resistance, Junction to Case | MD986 MD986F | RAJC | 125 250 | 87.5 125 | °C/W |
| Thermal Resistance, Junction to Ambient | MD986 MD986F | R _{ØJA} (1) | 319 500 | 292 438 | °C/W |
| | | | Junction to Ambient | Junction to Case | |
| Coupling Factors | MD986 MD986F | | 83 75 | 40 0 | % |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|----------------------|------------|------------|------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, IB = 0) | V _{(BR)CEO} | 15 | - | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 40 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 5.0 | | | Vdc |
| Collector Cutoff Current (VCB = 20 Vdc, IE = 0) (VCB = 20 Vdc, IE = 0, TA = 150°C) | ICBO | _ | | 25 30 | nAdc µAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 10 mAdc, VCE = 10 Vdc) | hFE | 25 | _ | _ | - |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) (I _C = 50 mAdc, I _B = 10 mAdc) | VCE(sat) | = | = | 0.3 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | V _{BE(sat)} | _ | _ | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 20 mAdc, V _{CE} = 20 Vdc, f = 100 MHz) (IC = 20 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) MD986F | fT | 200 200 | 320 320 | = | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | _ | _ | 4.0 | pF |

(2) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

MAXIMUM RATINGS

| MAXIMUM RATINGS | | | | |
|--|-----------------------------------|---|---|----------------|
| Rating | Symbol | Va | lue | Unit |
| Collector-Emitter Voltage | VCEO | 30 | | Vdc |
| Collector-Base Voltage | V _{CBO} | 6 | i0 | Vdc |
| Emitter-Base Voltage | VEBO | 5 | .0 | Vdc |
| Collector Current — Continuous | lc | 5 | 00 | mAdc |
| | | One Die | All Die Equal Power | |
| Total Device Dissipation @ T _A = 25°C MD1120, MD1121, MD1122 MD1120F, MD1121F, MD1122F MQ1120 Derate above 25°C MD1120, MD1121, MD1122 MD1120F, MD1121F, MD1122F MQ1120 | PD | 575 350 400 3.29 2.0 2.28 | 625 400 600 3.57 2.28 3.42 | mW/°C |
| Total Device Dissipation @ T _C = 25°C MD1120, MD1121, MD1122 MD1120F, MD1121F, MD1122F M01120 Derate above 25°C MD1120, MD1121, MD1122 MD1120F, MD1121F, MD1122F M01120 | PD | 1.8 1.0 0.9 10.3 5.71 5.13 | 2.5 2.0 3.6 14.3 11.4 20.5 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 65 to | + 200 | °C |

MD1120,F MD1121,F MD1122,F MQ1120

MD1120, MD1121, MD1122 CASE 654-07, STYLE 1

MD1120F CASE 610A-04, STYLE 1

MQ1120 CASE 607-04, STYLE 1

DUAL AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MD2218,A for graphs.

THERMAL CHARACTERISTICS

| Characteristic | Symbol | One Die | Ail Die Equal Power | Unit |
|--|-------------------|------------------------|------------------------|------|
| Thermal Resistance, Junction to Case MD1120, MD112 MD1120F. MD1 | | 97 175 | 70 87.5 | °C/W |
| MQ1120 | 211,141011221 | 195 | 48.8 | |
| Thermal Resistance, Junction to Ambient MD1120, MD112 MD1120F, MD1 MQ1120 | | 304 500 438 | 280 438 292 | °C/W |
| | | Junction to Ambient | Junction to Case | Unit |
| Coupling Factors | | | | % |
| MD1120, MD112 MD1120F, MD1 | 121F, MD1122F | 84 75 | 0 | |
| MQ1120 (Q1-Q: (Q1-Q: | 2) 3 or Q1-Q4) | 57 55 | 0 | |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|----------|-----|----------|----------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, IB = 0) | V(BR)CEO | 30 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 60 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 50 Vdc, I_E = 0) (V _{CB} = 50 Vdc, I_E = 0, T_A = 150°C) | ІСВО | = | <u>-</u> | 10 10 | nAdc μAdc |
| Emitter Cutoff Current (VEB = 3.0 Vdc, IC = 0) | IEBO | _ | | 10 | nAdc |

MD1120,F, MD1121,F, MD1122,F, MQ1120

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|--|----------------------|----------------------|--------------------------|------|
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(2) (IC = 10 μ Adc, VCE = 10 Vdc) (IC = 100 μ Adc, VCE = 10 Vdc) (IC = 1.0 mAdc, VCE = 10 Vdc) (IC = 10 mAdc, VCE = 10 Vdc) | hFE | 20 30 40 50 | 40 50 60 65 | 100 120 160 200 | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | V _{CE(sat)} | _ | 80 | 100 | mVdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | V _{BE(sat)} | _ | 700 | 850 | mVdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product(2) (IC = 20 mAdc, VCE = 20 Vdc, f = 100 MHz) | fτ | 200 | 250 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | _ | 3.5 | 8.0 | pF |
| MATCHING CHARACTERISTICS | | | - | | • |
| DC Current Gain Ratio(3) (I _C = 100 μAdc, V _{CE} = 10 Vdc) (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) All Devices MD1122, MD1122F | hFE1/hFE2 | 0.8 0.9 | = | 1.0 1.0 | |
| Base-Emitter Voltage Differential (IC = 100 μAdc, VCE = 10 Vdc) (IC = 1.0 mAdc, VCE = 10 Vdc) All Devices MD1122, MD1122F | VBE1-VBE2 | = | _ | 10 5.0 | mVdc |
| Base-Emitter Voltage Differential Change Due to Temperature — MD1121, MD1122 (IC = 100 μAdc, VCE = 10 Vdc, TA = -55 to +25°C) (IC = 100 μAdc, VCE = 10 Vdc, TA = +25 to +125°C) | Δ(V _{BE1} -V _{BE2}) | = | = | 0.8 1.0 | mVdc |

⁽²⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%. (3) The lowest hFE reading is taken as hFE1 for this ratio.

MAXIMUM RATINGS

| MAXIMUM RATINGS | | | | |
|--|----------------------|----------------------------|----------------------------|-------|
| Rating | Symbol | Value | | Unit |
| Collector-Emitter Voltage | VCEO | 4 | 0 | Vdc |
| Collector-Base Voltage | VCBO | 6 | 0 | Vdc |
| Emitter-Base Voltage | VEBO | 5. | 0 | Vdc |
| Collector Current — Continuous | lc | 20 | 00 | mAdc |
| | | One Die | All Die | |
| Total Device Dissipation | PD | | | mW |
| @ T _A = 25°C MD1123, MD1130 MD1130F Derate above 25°C MD1123, MD1130 MD1130F | | 575 350 3.29 2.0 | 625 400 3.57 2.28 | mW/°C |
| Total Device Dissipation | PD | | | Watts |
| @ T _C = 25°C MD1123, MD1130 MD1130F Derate above 25°C MD1123, MD1130 MD1130F | | 1.8 1.0 10.3 5.71 | 2.5 2.0 14.3 11.4 | mW/°C |
| Operating and Storage Junction Temperature Range | Tj, T _{stg} | -65 to +200 | | ~c |

MD1123 MD1130,F

MD1123 MD1130 CASE 654-07, STYLE 1

MD1130F CASE 610-A04, STYLE 1

DUAL AMPLIFIER TRANSISTOR

PNP SILICON

THERMAL CHARACTERISTICS

| Characteristic | | Symbol | One Die | All Die Equal Power | Unit |
|---|---------------------------|----------------------|------------------------|------------------------|------|
| Thermal Resistance, Junction to Case | MD1123, MD1130 MD1130F | R _{ØJC} | 97 175 | 70 87.5 | °C/W |
| Thermal Resistance, Junction to Ambient | MD1123, MD1130 MD1130F | R _{ØJA} (1) | 304 500 | 280 438 | °C/W |
| | | | Junction to Ambient | Junction to Case | |
| Coupling Factors | MD1123, MD1130 MD1130F | | 84 75 | 44 0 | % |

(1) R_{BJA} is measured with the device soldered into a typical printed circuit board.

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|--------------------|------------------|-----------|-----------|--------------|--------------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, IB = 0) | | V(BR)CEO | 40 | _ | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 μAdc, IE = 0) | | V(BR)CBO | 60 | - | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 50 Vdc, I _E = 0) (VCB = 50 Vdc, I _E = 0, T _A = 150°C) | | СВО | <u>-</u> | _ | 10 10 | nAdc μAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | | ^I EBO | _ | | 10 | nAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain(2) (I _C = 10 μAdc, V _{CE} = 10 Vdc) | MD1130,F | hFE | 60 | 100 | - | _ |
| (I _C = 100 μAdc, V _{CE} = 10 Vdc) | MD1123 MD1130F | | 30 100 | 80 170 | 120 300 | |
| (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) | MD1130,F | | 100 | 180 | - | |
| (IC = 10 mAdc, VCE = 10 Vdc) | MD1123 MD1130,F | | 50 100 | 75 150 | 200 | |

MD1123, MD1130,F

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|--------------------|--------------------------------------|------------|------------|------------|------|
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 Adc) | | VCE(sat) | _ | 0.18 | 0.25 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | - | V _{BE(sat)} | _ | 0.8 | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product (I _C = 20 mAdc, V _{CE} = 20 Vdc, f = 100 MHz) | MD1123 MD1130,F | fT | 250 200 | 600 550 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 100 kHz) | | Copo | _ | 3.5 | 4.0 | pF |
| MATCHING CHARACTERISTICS | | | | | | |
| DC Current Gain Ratio(3) (I _C = 100 µAdc, V _{CE} = 10 Vdc) | MD1123 MD1130,F | hFE1/hFE2 | 0.8 0.9 | _ | 1.0 1.0 | _ |
| Base-Emitter Voltage Differential (IC = 100 µAdc, VCE = 10 Vdc) (IC = 1.0 mAdc, VCE = 10 Vdc) | MD1123 MD1130,F | IVBE1-VBE2 | _ | = | 10 5.0 | mVdc |
| Base-Emitter Voltage Differential Change Due to Temperature — MD1121, MD1122 (IC = 100 µAdc, VCE = 10 Vdc, T _A = +25 to +125°C) | MD1130,F | Δ V _{BE1} /V _{BE2} | _ | _ | 10 | mVdc |

⁽²⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

⁽³⁾ The lowest hee reading is taken as hee1 for this ratio.

| MAXIMUM RATINGS | | | | |
|-------------------------------------|----------------------|------------|------------------------|-------|
| Rating | Symbol | Vŧ | lue | Unit |
| Collector-Emitter Voltage | VCEO | | Vdc | |
| Collector-Base Voltage | VCBO | | 50 | Vdc |
| Emitter-Base Voltage | VEBO | 5 | i.0 | Vdc |
| Collector Current — Continuous | lc | 5 | 00 | mAdc |
| | • | One Die | All Die Equal Power | |
| Total Power Dissipation @ TA = 25°C | PD | | | mW |
| MD1129 | | 675 | 625 | |
| MD129F MQ1129 | 1 | 350 400 | 400 600 | |
| Derate above 25°C | Ì | 400 | 000 | mW/°C |
| MD1129 | 1 | 3.29 | 3.57 | |
| MD1129F | | 2.9 | 2.28 | |
| MQ1129 | | 2.28 | 3.42 | |
| Total Device Dissipation | PD | | | Watts |
| @ T _C = 25°C MD1129 |] | 1.8 | 2.5 | watts |
| MD1129F | 1 1 | 1.0 | 2.0 | |
| MQ1129 | 1 | 0.9 | 3.6 | |
| Derate above 25°C | | | | mW/°C |
| MD1129 | | 10.3 | 14.3 | |
| MD1129F | 1 | 5.71 | 11.4 | } |
| MQ1129 | | 5.13 | 20.5 | |
| Operating and Storage Junction | TJ, T _{stg} | 65 t | o +200 | *℃ |

MD1129,F MQ1129

MD1129 **CASE 654-07, STYLE 1**

MD1129F **CASE 610A-04, STYLE 1**

MQ1129 **CASE 607-04, STYLE 1**

DUAL AMPLIFIER TRANSISTOR

NPN SILICON

THERMAL CHARACTERISTICS

| Characteristic | | Symbol | One Die | All Die Equal Power | Unit |
|---|---------------|-----------|-------------|------------------------|------|
| Thermal Resistance, Junction to Case | | RAJC | | | °C/W |
| | MD1129 | 1 | 97 | 70 | |
| | MD1129F | i | 175 | 87.5 | |
| | MQ1129 | | 195 | 48.8 | |
| Thermal Resistance, Junction to Ambient | <u> </u> | ReJA(1) | 304 | 280 | °C/W |
| | | ~~~ | 500 | 438 | |
| | | - | 438 | 292 | |
| | | | Junction to | Junction to | |
| | | | Ambient | Case | Unit |
| Coupling Factors | | | | | % |
| oospg . co.o.o | MD1129 | | 84 | 44 | |
| | MD1129F | | 75 | 0 | |
| | MQ1129 (Q1-Q2 | ?) | 57 | 0 | |
| | (Q1-Q3 | or Q1-Q4) | 55 | 0 | |

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|-----------------------|-----|-----|----------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (I _C = 10 mAdc, I _B = 0) | V(BR)CEO | 30 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V _(BR) CBO | 60 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | V _{(BR)EBO} | 5.0 | _ | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 50 Vdc, I _E = 0) (V _{CB} = 50 Vdc, I _E = 0, T _A = 150°C) | ICBO | | 1 - | 10 10 | nAdc µAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | IEBO | _ | - | 10 | nAdc |

MD1129,F, MQ1129

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|--|-------------------------|--------------------|-------------|------|
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(2) (I _C = 10 μAdc, V _{CE} = 10 Vdc) (I _C = 100 μAdc, V _{CE} = 10 Vdc) (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc) | hFE | 60 100 100 100 | 120 140 | 300 — | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) MD1129, MQ1129 MD1129F | V _{CE(sat)} | <u>-</u> | 0.09 | 0.1 0.15 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | V _{BE(sat)} | _ | 0.7 | 0.85 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product(2) (I _C = 20 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | fŢ | 200 | 250 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | C _{obo} | _ | 3.5 | 8.0 | pF |
| MATCHING CHARACTERISTICS (MD1129, MD1129F) | | | | | |
| DC Current Gain Ratio(3) (IC = 100 μAdc, VCE = 10 Vdc) (IC = 1.0 mAdc, VCE = 10 Vdc) | hFE1/hFE2 | 0.9 0.9 | 1 1 | 1.0 1.0 | _ |
| Base-Emitter Voltage Differential (IC = 100 μAdc, VCE = 10 Vdc) (IC = 1.0 mAdc, VCE = 10 Vdc) | VBE1-VBE2 | - | = | 5.0 5.0 | mVdc |
| Base-Emitter Voltage Differential Change Due to Temperature (IC = 100 μAdc, VCE = 10 Vdc, T _A = -55 to +25°C) (IC = 100 μAdc, VCE = 10 Vdc, T _A = +25 to +125°C) | Δ(V _{BE1} -V _{BE2}) | 11 | = | 0.8 1.0 | mVdc |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board. (2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

⁽³⁾ The lowest hee reading is taken as hee1 for this ratio.

MAXIMUM RATINGS

| Rating | Symbol | Value | | Unit | | |
|---|-----------------------------------|-------------|-------------|----------------|--|------|
| Collector-Emitter Voltage | VCEO | 1 | 15 | | | |
| Collector-Base Voltage | VCBO | 30 | | 30 | | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | | 5.0 | | Vdc |
| Collector Current — Continuous | lc | 50 | | 50 | | mAdc |
| | | One Die | Both Die | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 550 3.14 | 600 3.42 | mW mW/℃ | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.4 8.0 | 2.0 11.4 | Watts mW/°C | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | °C | | |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | One Die | Both Die Equal Power | Unit |
|---|----------------------|------------------------|-------------------------|------|
| Thermal Resistance, Junction to Case | R _Ø JC | 125 | 87.5 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{6JA} (1) | 319 | 292 | °C/W |
| | | Junction to Ambient | Junction to Case | Unit |
| Coupling Factors | | 83 | 40 | . % |

MD1132,F

MD1132F **CASE 610A-04, STYLE 1**

MD1132 **CASE 654-07, STYLE 1**

DUAL RF AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MD918 for graphs.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|--|-----|------------|------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (I _C = 3.0 mAdc, I _B = 0) | V(BR)CEO | 15 | T - | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 1.0 µAdc, IE = 0) | V(BR)CBO | 30 | | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | V _{(BR)EBO} | 5.0 | | _ | Vdc |
| Collector Cutoff Current ($V_{CB} = 15 \text{ Vdc}$, $E = 0$) ($V_{CB} = 15 \text{ Vdc}$, $E = 0$, $T_{A} = 150^{\circ}\text{C}$) | ICBO | _ | = | 10 1.0 | nAdc μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(2) (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc) | hFE | 50 | _ | _ | I – |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | V _{CE(sat)} | _ | 0.2 | 0.4 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | V _{BE(sat)} | _ | 0.7 | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (I _C = 4.0 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | fτ | 600 | 800 | _ | _ |
| Output Capacitance (VCB = 0, I _E = 0, f = 140 kHz) (VCB = 10 Vdc, I _E = 0, f = 140 kHz) | Copo | | 1.5 1.3 | 3.0 1.7 | pF |
| Input Capacitance (VEB = 0.5 Vdc, IC = 0, f = 140 kHz) | Cibo | _ | 1.8 | 2.0 | pF |
| MATCHING CHARACTERISTICS | | | | | • |
| DC Current Gain Ratio(3) (IC = 1.0 mAdc, VCE = 5.0 Vdc) | hFE1/hFE2 | 0.9 | _ | 1.0 | _ |
| Base-Emitter Voltage Differential (IC = 1.0 mAdc, VCE = 5.0 Vdc) | VBE1-VBE2 | _ | _ | 5.0 | mVdc |
| Base-Emitter Voltage Differential Change Due to Temperature (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc, T _A = -55 to +25°C) (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc, T _A = +25 to +125°C) | Δ(V _{BE1} -V _{BE2}) | = | <u>-</u> | 0.8 1.0 | mVdc |

⁽¹⁾ Raja is measured with the device soldered into a typical printed circuit board.

⁽²⁾ Pulse Test: Pulse Width < 300 μ s, Duty Cycle < 2.0%. (3) The lowest hFE reading is taken as hFE1 for this ratio.

MD2218,A,F,AF MD2219,A,F,AF MQ2218,A MQ2219,A

MD2218,A MD2219,A CASE 654-07, STYLE 1

MD2218F,AF

MD2219F,AF

CASE 610A-04, STYLE 1

MQ2218,A MQ2219,A CASE 607-04, STYLE 1

DUAL AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | MD2218,A,F MD2219,A,F MQ2218,A MQ2219,A | MD2218AF | Unit |
|--|----------------------|--|---|-------|
| Collector-Emitter Voltage | VCEO | 30 | 40 | Vdc |
| Collector-Base Voltage | VCBO | 60 | 75 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | 6.0 | Vdc |
| Collector Current — Continuous | lc | 5 | 00 | mAdc |
| | | One Die | All Die Equal Power | |
| Total Device Dissipation (a) TA = 25°C MD2218,A, MD2219,A MD2218,AF, MD2219F,AF MO2218,A, MQ2219,A Derate above 25°C MD2218,A, MD2219,A MD2218,A, MD2219F,AF MO2218,A, MO2219,A | PD | 575 350 400 3.29 2.0 2.28 | 625 400 600 3.57 2.28 3.42 | mW/°C |
| Total Device Dissipation @ T _C = 25°C MD2218,A, MD2219,A MD2218,A, MD2219,A Derate above 25°C MD2218,A, MD2219,A MD2218,A, MD2219,A MD2218,A, MD2219,A MD2218,A, MD2219,A | PD | 1.8 1.0 0.9 10.3 5.71 5.13 | 2.5 2.0 3.6 14.3 11.4 20.5 | Watts |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to | + 200 | °C |

THERMAL CHARACTERISTICS

| Characteristi | Characteristic | | One Die | All Die Equal Power | Unit |
|---|---------------------------|-------------|------------------------|------------------------|------|
| Thermal Resistance, Junction to Case | | RAJC | | | °C/W |
| | MD2218,A, MD2219,A | 1 | 97 | 70 | |
| | MD2218F,AF, MD2219F,AF | | 175 | 87.5 | |
| | MQ2218,A, MQ2219,A | | 195 | 48.8 | |
| Thermal Resistance, Junction to Ambient | | Raja(1) | | | °C/W |
| | MD2218,A, MD2219,A | | 304 | 280 | |
| | MD2218,F,AF, MD2219,F,AF | | 500 | 438 | |
| | MQ2218,A, MQ2219,A | | 438 | 292 | |
| | | | Junction to Ambient | Junction to Case | |
| Coupling Factors | | | | ľ | % |
| • • | MD2218,A, MD2219,A | | 84 | 44 | |
| | MD2218F,AF, MD2219F,AF | | 75 | 0 | |
| | MQ2218,A, MQ2219,A (Q1-Q2 | 2) | 57 | 0 | |
| | (Q1-Q | 3 or Q1-Q4) | 55 | 0 | |

⁽¹⁾ R_{6JA} is measured with the device soldered into a typical printed circuit board.

| Cha | aracteristic | Symbol | Min | Тур | Max | Unit |
|-------------------------------------|-----------------------------------|----------|-----|-----|-----|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltag | e(2) | V(BR)CEO | | | | Vđc |
| | MD2218,A,F, MD2219,A,F, MQ2218,A, | | | | | |
| | MQ2219,A | | 30 | _ | . – | ĺ |
| | MD2218AF, MD2219AF | | 40 | | - | |
| Collector-Base Breakdown Voltage | | V(BR)CBO | | | | Vdc |
| $\{ C = 10 \mu\text{Adc}, E = 0\}$ | MD0040 A F MD0040 A F MO0040 A | | 1 | 1 | 1 | ľ |
| | MD2218,A,F, MD2219,A,F, MQ2218,A, | | | 1 | l | l |
| | MD2219,A | | 60 |) — | ı – | 1 |
| | MD2218AF, MD2219AF | | 75 | - | | l |

MD2218,A,F,AF, MD2219,A,F,AF, MQ2218,A, MQ2219,A

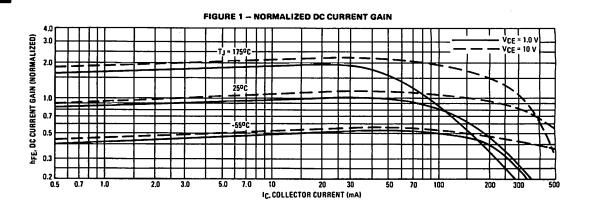
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

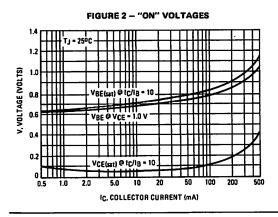
| | racteristic | Symbol | Min | Тур | Max | Unit |
|--|--|----------------------|----------|-----------|------------|-------|
| Emitter-Base Breakdown Voltage | | V(BR)EBO | | | | Vdc |
| (IE = 10 μAdc, IC = 0) | | TONIEDU | | | | "" |
| | MD2218,A,F, MD2219,A,F, MQ2218,A, | | 5.0 | _ | _ | 1 |
| | MQ2219,A MD2218AF, MD2219AF | | 6.0 | _ | _ |]] |
| Collector Cutoff Current | | ^I CEV | | | | nAdc |
| (VCE = 50 Vdc, VEB(off) = 3.0 Vd | | | 20 | | | |
| | MD2218,F, MD2219,F, MQ2218,A MD2218A,AF, MD2219A,AF, MQ2219,A | | 20 15 | _ | _ | ! i |
| Base Cutoff Current | | IBL | 30 | _ | _ | nAdc |
| (VCE = 50 Vdc, VEB(off) = 3.0 Vc | ic) | | | İ | | |
| ON CHARACTERISTICS(2) | | | | | | |
| DC Current Gain | | hFE | | | | - |
| (IC = 0.1 mAdc, VCE = 10 Vdc) | MD2218,A,F,AF, MQ2218,A | | 20 | 50 | _ | |
| | MD2219,A,F,AF, MQ2219,A | | 35 | 45 | - | |
| (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) | | | | | | |
| (10 110 111 100) VCE 10 100) | MD2218,A,F,AF, MQ2218,A | | 25 | 55 | _ | |
| | MD2219,A,F,AF, MQ2219,A | | 50 | 55 | _ | |
| (IC = 10 mAdc, VCE = 10 Vdc) | | | | ļ | | |
| 32 | MD2218,A,F,AF, MQ2218,A | | 35 | 65 | _ | |
| | MD2219,A,F,AF, MQ2219,A | | 75 | 85 | _ | |
| (IC = 150 mAdc, VCE = 1.0 Vdc) | | | | | | |
| | MD2218,A,F,AF, MQ2218,A MD2219,A,F,AF, MQ2219,A | İ | 20 50 | 65 65 | | : |
| | MOZZ TOJAJI JAT J MIGZZ TOJA | | 00 | " | | |
| (I _C = 150 mAdc, V _{CE} = 10 Vdc) | AADOOAG AF AF MODOAG A | | 40 | | 100 | i |
| | MD2218,AF,AF, MQ2218,A MD2219,A,F,AF, MQ2219,A | | 100 | 30 120 | 120 300 | |
| | | | | ł | | |
| (IC = 300 mAdc, VCE = 10 Vdc) | MD2218,A, MQ2218,A | | 25 | 75 | _ | |
| | MD2219,A, MQ2219,A | | 30 | 75 | | |
| Collector-Emitter Saturation Voltage | 1 | V _{CE(sat)} | | ĺ | | Vdc |
| (IC = 150 mAdc, IB = 15 mAdc) | MD2218,A,F, MD2219,A,F, MQ2218,A, | | | | | |
| | MQ2219,A | | – | 0.2 | 0.4 | |
| | MD2218AF, MD2219AF | | - | - | 0.3 | |
| (IC = 300 mAdc, IB = 30 mAdc) | | | | | | |
| | MD2218,A,F, MD2219,A,F, MQ2218,A, | | _ | 0.35 | 1.2 | |
| | MQ2219,A MD2218AF, MD2219AF | | = | 0.35 | 1.2 0.9 | |
| Base-Emitter Saturation Voltage | | V _{BE(sat)} | | | | Vdc |
| (IC = 150 mAdc, IB = 15 mAdc) | MD2219 A E MD2210 A E MO2210 A | | | 1 | | |
| | MD2218,A,F, MD2219,A,F, MQ2218,A, MQ2219,A | | 0.6 | 0.95 | 1.3 | |
| | MD2218AF, MD2219AF | | 0.6 | 1.0 | 1.2 | |
| ((c = 300 mAde, lp = 30 mAde)) | //D2218,A,F, MD2219,A,F, MQ2218,A, | | | 1 | | |
| , i.e. our in ind iB on in additi | MQ2219,A | | - | _ | 2.0 | |
| | MD2218AF, MD2219AF | | | <u> </u> | 1.8 | |
| SMALL-SIGNAL CHARACTERISTICS | | , , , | 000 | 1 000 | · · | 1 40: |
| Current-Gain — Bandwidth Product (IC = 20 mAdc, VCE = 20 Vdc, f | | fT | 200 | 250 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 k | ··Hz) | C _{obo} | - | 3.5 | 8.0 | pF |
| Input Capacitance | | Cibo | | | | ρF |
| (VEB = 0.5 Vdc, IC = 0, f = 100 l | kHz) MD2218,A,F, MD2219,A,F, MQ2218,A, | | | | | |
| | MQ2219,A | | | 15 | 20 | |
| | MD2218AF, MD2219AF | L | | 18 | 25 | L |

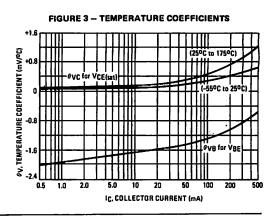
MD2218,A,F,AF, MD2219,A,F,AF, MQ2218,A, MQ2219,A

| | Characteristic | Symbol | Min | Тур | Max | Unit | | | | |
|---------------------------|--|----------------|-----|-----|------------|------|--|--|--|--|
| SWITCHING CHARACTERISTICS | | | | | | | | | | |
| Delay Time | (V _{CC} = 30 Vdc, I _C = 150 mAdc, V _{BE} (off) = 0.5 Vdc, I _{B1} = 15 mAdc) MD2218,F, MD2219,F MD2218A,AF, MD2219A,AF | td | _ | | 20 15 | μ8 | | | | |
| Rise Time | MD2218,F, MD2219,F MD2218A,AF, MD2219A,AF | tr | = | = | 40 30 | μs | | | | |
| Storage Time | (V _{CC} = 30 Vdc, I _C = 150 mAdc, I _{B1} = I _{B2} = 15 mAdc) MD2218,F, MD2219,F MD2218A,AF, MD2219A,AF | t _s | _ | _ | 280 250 | μs | | | | |
| Fall Time | MD2218,F, MD2219,F MD2218A,AF, MD2219A,AF | tf | _ | = | 70 60 | μs | | | | |

⁽²⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.





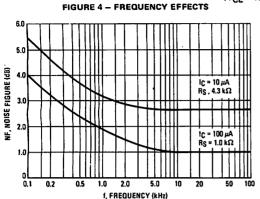


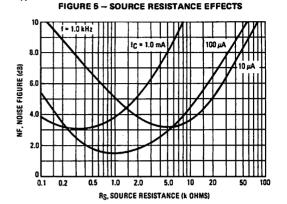
SMALL-SIGNAL DEVICES

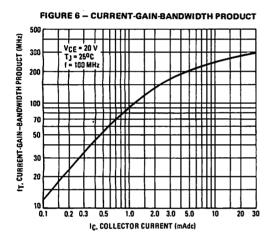
MD2218.A.F.AF, MD2219.A.F.AF, MQ2218.A. MQ2219.A

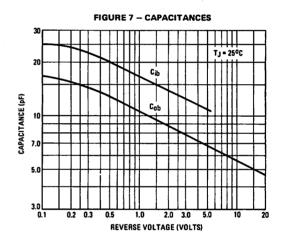
NOISE FIGURE

(V_{CE} = 10 Vdc, T_A = 25°C)

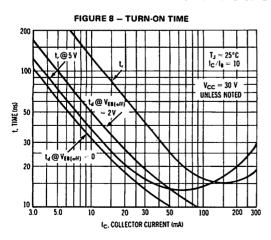


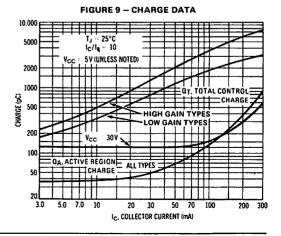




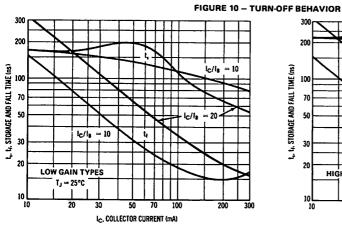


SWITCHING TIME CHARACTERISTICS





MD2218,A,F,AF, MD2219,A,F,AF, MQ2218,A, MQ2219,A



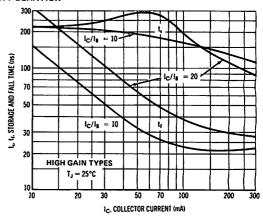
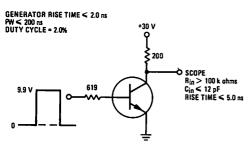
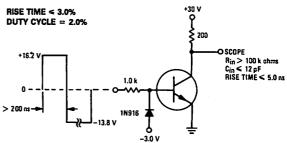


FIGURE 11 - DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT

FIGURE 12 – STORAGE TIME AND FALL TIME EQUIVALENT TEST CIRCUIT





| MAXIMUM RATINGS | | | | | |
|---|-----------------------------------|-------------------|------------------------|-------|--|
| Rating | Symbol | V | Value | | |
| Collector-Emitter Voltage | VCEO | | Vdc | | |
| Collector-Base Voltage | V _{CBO} | | 40 | Vdc | |
| Emitter-Base Voltage | VEBO | | 5.0 | Vdc | |
| Collector Current — Continuous | lc | 5 | 000 | mAdc | |
| | | One Die | All Die Equal Power | | |
| Total Device Dissipation @ T _A = 25°C | PD | | | mW | |
| MD2369,A,B MD2369F,AF,BF MQ2369 | | 550 350 400 | 600 400 600 | | |
| Derate above 25°C MD2369,A,B MD2369F,AF,BF | | 3.14 2.0 | 3.42 2.28 | mW/°C | |
| MQ2369 Total Device Dissipation | PD | 2.28 | 3.42 | Watts | |
| @ T _C = 25°C MD2369A,B MD2369F,AF,BF MQ2369 Derate above 25°C MD2369A,B | | 1.4 0.7 0.7 | 2.0 1.4 2.8 | mW/°C | |
| MD2369F,AF,BF MD2369 MQ2369 | | 4.0 4.0 | 80 16 | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 65 t | o +200 | ů | |

MD2369,A,B MD2369F,AF,BF MQ2369

MD2369,A,B **CASE 654-07, STYLE 1**

MD2369F.AF.BF **CASE 610A-04, STYLE 1**

MQ2369 **CASE 607-04, STYLE 1**

DUAL **GENERAL PURPOSE TRANSISTOR**

NPN SILICON

not monolithic 1854-1016

THERMAL CHARACTERISTICS

| Characteristic | | Symbol | One Die | All Die Equal Power | Unit |
|---|---|----------------------|------------------------|------------------------|------|
| Thermal Resistance, Junction to Case | MD2369,A,B MD2369F,AF,BF MQ2369 | R _{ØJ} C | 125 250 250 | 87.5 125 62.6 | °CW_ |
| Thermal Resistance, Junction to Ambient | MD2369,A,B MD2369F,AF,BF MQ2369 | R _{ØJA} (1) | 319 500 438 | 292 438 292 | °C/W |
| | | | Junction to Ambient | Junction to Case | _ |
| Coupling Factor | MD2369,A,B MD2369F,AF,BF MQ2369 (Q1-Q2) | | 83 75 57 | 40 0 0 | % |
| | (Q1-Q3 o | r Q1-Q4) | 55 | 0 | |

⁽¹⁾ Raja is measured with the device soldered into a typical printed circuit board.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|----------|----------|----------|------------|------|
| OFF CHARACTERISTICS | | | | *- | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, IB = 0) | V(BR)CEO | 15 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, I _E = 0) | V(BR)CBO | 40 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | | Vdc |
| Collector Cutoff Current (V _{CB} = 20 Vdc, I _E = 0) (V _{CB} = 20 Vdc, I _E = 0, T _A = +150°C) | ІСВО | = | = | 0.03 30 | μAdo |
| ON CHARACTERISTICS(2) | | | <u> </u> | · | |
| DC Current Gain (IC = 10 mAdc, VCE = 1.0 Vdc) (IC = 10 mAdc, VCE = 1.0 Vdc, Ta = -55°C) | hFE | 40 20 | 95 | 140 | _ |

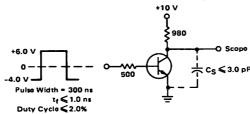
MD2369,A,B, MD2369F,AF,BF, MQ2369

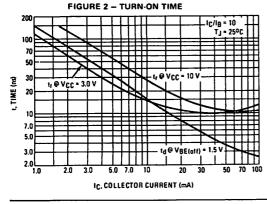
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

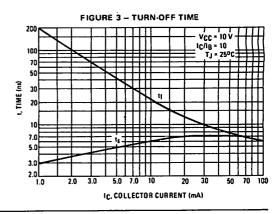
| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|--|---|------------|-----|------------|-------|
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | | V _{CE(sat)} | _ | ı | 0.25 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | | V _{BE(sat)} | 0.7 | - | 0.85 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product(2) (IC = 10 mAdc, VCE = 10 Vdc, f = 100 MHz) | | fT | 500 | 800 | 1 | MHz |
| Output Capacitance (VCB = 5.0 Vdc, IE = 0, f = 100 kHz) | | C _{obo} | _ | _ | 4.0 | pF |
| Input Capacitance (VBE = 1.0 Vdc, IC = 0, f = 100 MHz) | | C _{ibo} | _ | - | 4.0 | pF |
| SWITCHING CHARACTERISTICS | | | | | | |
| Storage Time (VCC = 10 Vdc, IC = IB1 = IB2 = 10 mAdc) | | t _S | _ | _ | 13 | ns |
| Turn-On Time (VCC = 3.0 Vdc, VBE(off) = 1.5 Vdc, IC = 10 | mAdc, I _{B1} = 3.0 mAdc) | ton | _ | _ | 15 | ns |
| Turn-Off Time (VCC = 3.0 Vdc, IC = 10 mAdc, IB1 = 3.0 mA | Adc, 1 ₈₂ = 1.5 mAdc) | ^t off | _ | _ | 20 | กร |
| MATCHING CHARACTERISTICS | | | | | | |
| DC Current Gain Ratio(3) (IC = 3.0 mAdc, VCE = 1.0 Vdc) | MD2369A, MD2369AF MD2369B, MD2369BF | hFE1/hFE2 | 0.9 0.8 | _ | 1.0 1.0 | _ |
| Base-Emitter Voltage Differential (IC = 3.0 mAdc, VCE = 1.0 Vdc) | MD2369A, MD2369AF MD2369B, MD2369BF | VBE1-VBE2 | | - | 5.0 10 | mVdc |
| Base-Emitter Voltage Differential Gradient (IC = 3.0 mAdc, VCE = 1.0 Vdc, TA = -55 to +125°C) | MD2369A, MD2369AF MD2369B, MD2369BF | Δ(V _{BE1} -V _{BE2}) ΔΤ _Α | - | | 10 20 | μV/°C |

- (2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.
- (3) The lowest hee reading is taken as hee1 for this test.

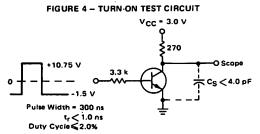
FIGURE 1 - STORAGE TIME TEST CIRCUIT

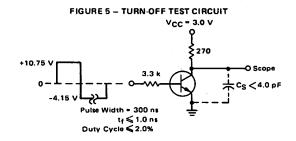


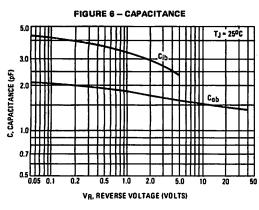


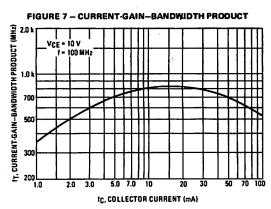


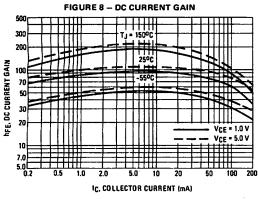
MD2369,A,B, MD2369F,AF,BF, MQ2369

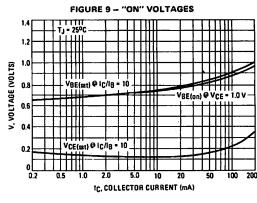


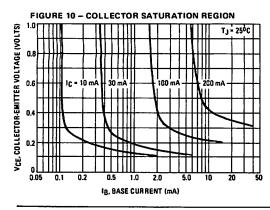


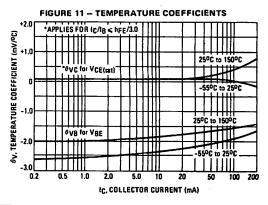












MD2904,A,F,AF MD2905,A,F,AF MQ2904, MQ2905A

MD2904,A MD2905,A CASE 654-07, STYLE 1

MD2904F,AF MD2905F,AF CASE 610A-04, STYLE 1

MQ2904 MQ2905A CASE 607-04, STYLE 1

DUAL AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| WANTED IN TATIFECT | | | | |
|---|-----------------------------------|--------------------------------|-------------------------------------|--------|
| Rating | Symbol | MD2904,F MD2905,F MQ2904 | MD2904A,AF MD2905A,AF MQ2905A | Unit |
| Collector-Emitter Voltage | VCEO | 40 | 60 | Vdc |
| Collector-Base Voltage | VCBO | (| 30 | Vdc |
| Emitter-Base Voltage | VEBO | 5 | 5.0 | Vdc |
| Collector Current — Continuous | lc | 6 | 00 | mAdc |
| | | One Die | All Die Equal Power | |
| Total Device Dissipation @ TA = 25°C | PD | | | mW |
| MD2904,A, MD2905,A | | 575 | 625 | |
| MD2904F,AF, MD2905,AF | 1 | 350 400 | 400 600 | mW/°C |
| MQ2904, MQ2905A Derate above 25°C | ĺ | 400 | 600 | mvv/·C |
| MD2904,A, MD2905,A | l i | 3.29 | 3.57 | |
| MD2904,F,AF, MD2905F,AF | | 2.0 | 2.28 | |
| MQ2904, MQ2905A | | 2.28 | 3.42 | |
| Total Device Dissipation @ Tc = 25°C | PD | | | Watts |
| MD2904,A, MD2905,A | · | 1.8 | 2.5 | İ |
| MD2904F,AF, MD2905F,AF | i | 1.0 | 2.0 | 1 |
| MQ2904, MQ2905A | | 0.9 | 3.6 | mW/°C |
| Derate above 25°C | | | 1 440 | |
| MD2904,A, MD2905,A | | 10.3 5.71 | 14.3 11.4 | 1 |
| MD2904F,AF, MD2905F,AF MQ2904, MQ2905A | | 5.13 | 20.5 | (|
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 65 t | 0 +200 | ℃ |

THERMAL CHARACTERISTICS

| Characteris | tic | Symbol | One Die | All Die Equal Power | Unit |
|---|---|----------------------|------------------------|------------------------|------|
| Thermal Resistance, Junction to Case | MD2904,A, MD2905,A MD2904F,AF, MD2905F,AF MQ2904, MQ2905A | R&IC | 97 175 195 | 70 87.5 48.8 | °C/W |
| Thermal Resistence, Junction to Ambient | MD2904,A, MD2905,A MD2904F,AF, MD2905F,AF MQ2904, MQ2905A | R _{ØJA} (1) | 304 500 438 | 280 438 292 | °C/W |
| | | | Junction to Ambient | Junction to Case | |
| Coupling Factor | Factor MD2904,A, MD2905,A MD2904F,AF, MD2905F,AF MQ2904, MQ2905A (Q1-Q2) (Q1-Q3 or | | 84 75 57 55 | 44 0 0 | % |

⁽¹⁾ R_{6JA} is measured with the device soldered into a typical printed circuit board.

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|------------------------------------|----------|----------|-----|-------------|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage(2) (I _C = 10 mAdc, I _B = 0) | MD2904, MD2905 MD2904A, MD2905A | V(BR)CEO | 40 60 | _ | = | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | | V(BR)CBO | 60 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | | Vdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) (VCB = 50 Vdc, IE = 0, TA = 150°C) | | ІСВО | - | | 0.020 30 | μAdc |

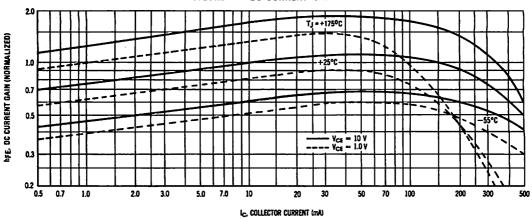
MD2904,A,F,AF, MD2905,A,F,AF, MQ2904, MQ2905A

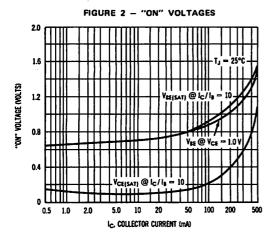
| Characteristic Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | | Symbol | Min — | Тур | Max 30 | Unit nAdc |
|---|--|----------------------|-----------------------|------------------------|------------------|--------------|
| | | IEBO | | | | |
| ON CHARACTERISTICS(2) | | | | | | |
| DC Current Gain (I _C = 0.1 mAdc, V _{CE} = 10 Vdc) | MD2904 MD2904A MD2905 MD2905A | hFE | 20 40 35 75 | 50 70 70 150 | 1111 | 1 |
| (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) | MD2904 MD2904A MD2905 MD2905A | | 25 40 50 100 | 75 75 100 175 | 1111 | |
| (I _C = 10 mAdc, V _{CE} = 10 Vdc) | MD2904 MD2904A MD2905 MD2905A | | 35 40 75 100 | 90 90 110 200 | - - - | |
| (I _C = 150 mAdc, V _{CE} = 10 Vdc) | MD2904,A, MD2905,A | | 40 100 | 90 200 | 120 300 | |
| (I _C = 500 mAdc, V _{CE} = 10 Vdc) | MD2904 MD2904A MD2905 MD2905A | | 20 40 30 50 | 60 80 130 150 | = = | |
| Collector-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) (IC = 500 mAdc, IB = 50 mAdc) | | VCE(sat) | = | 0.25 0.5 | 0.4 1.6 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc) (I _C = 500 mAdc, I _B = 50 mAdc) | | V _{BE(sat)} | | 0.88 1.0 | 1.3 2.6 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | 200 | 1 220 | | Aeu- |
| Current-Gain — Bandwidth Product(3) (IC = 50 mAdc, VCE = 20 Vdc, f = 100 MHz) | | fτ | 200 | 320 | - | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | | C _{obo} | _ | 5.8 | 8.0 | pF |
| Input Capacitance ($V_{BE} = 2.0 \text{ Vdc, I}_{C} = 0, f = 100 \text{ kHz}$) | | Cibo | _ | 16 | 30 | pF |
| SWITCHING CHARACTERISTICS | | | · | , | | |
| Turn-On Time (V _{CC} = 30 Vdc, | (ACC = 20 And, ABE = 0.5 Add, | | | <u> </u> | 45 | ns |
| Delay Time IC = 150 mAdc, IB1 = 15 mAdc) IB1 = 15 mAdc) | | <u>td</u> | - | - | 12 | ns |
| | | tr | | - | 35 | ns |
| Turn-Off Time (V _{CC} = 30 Vdc, Storage Time I _C = 150 mAdc, Fail Time I _{B1} = I _{B2} = 15 mAdc) | | toff | | _ | 130 | ns |
| | | ts | <u> </u> | <u> </u> | 100 | ns |
| | | tę | – | _ | 40 | ns |

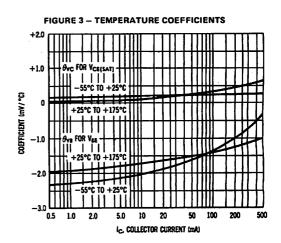
⁽²⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%. (3) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MD2904,A,F,AF, MD2905,A,F,AF, MQ2904, MQ2905A



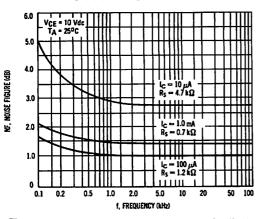


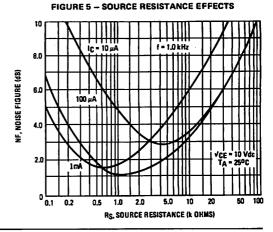




NOISE FIGURE VCE = 10 V, TA = 25°C

FIGURE 4 - FREQUENCY EFFECTS

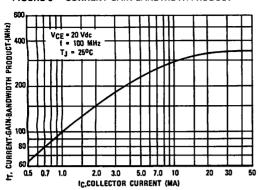


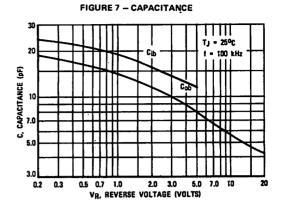


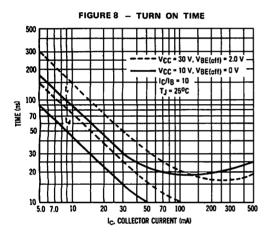
SMALL-SIGNAL DEVICES

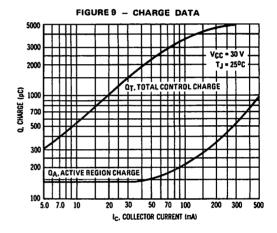
MD2904.A.F.AF. MD2905.A.F.AF. MQ2904. MQ2905A

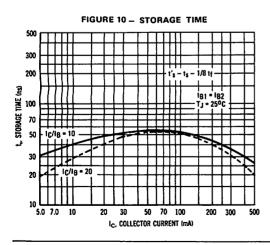
FIGURE 6 - CURRENT-GAIN BANDWIDTH PRODUCT

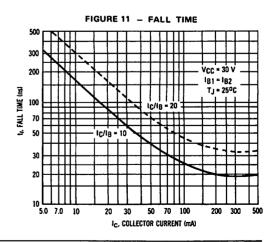










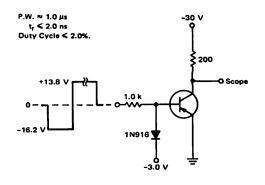


MD2904,A,F,AF, MD2905,A,F,AF, MQ2904, MQ2905A

FIGURE 12 - DELAY AND RISE TIME TEST CIRCUIT

P.W. > 200 ns t_r < 2.0 ns Duty Cycle < 2.0%.

FIGURE 13 — STORAGE AND FALL TIME TEST CIRCUIT



MAXIMUM RATINGS

| MAXIMUM RATINGS | | _ | | |
|---|----------------------|---|---|-------|
| Rating | Symbol | V | elue | Unit |
| Collector-Emitter Voltage | VCEO | | 40 | Vdc |
| Collector-Base Voltage | VCBO | | 50 | Vdc |
| Emitter-Base Voltage | VEBO | 9 | 5.0 | Vdc |
| Collector Current — Continuous | lc | | 50 | mAdc |
| | | One Die | All Die Equal Power | |
| Total Device Dissipation @ T _A = 25°C | PD | | | mW |
| MD3250,A, MD3251,A MD3250F,AF, MD3251F,AF MQ3251 Derate above 25°C MD3250,A, MD3251,A MD3250F,AF, MD3251F,AF MQ3251 | | 575 350 400 3.29 2.0 2.28 | 625 400 600 3.57 2.28 3.42 | mW/°C |
| Total Device Dissipation @ Tc = 25°C | PD | | | Watts |
| MD3250,A, MD3251,A MD3250F,AF, MD3251F,AF M03251 Derate above 25°C MD3250,A, MD3251,A MD3250F,AF, MD3251F,AF MQ3251 | | 1.8 1.0 0.9 10.3 5.71 5.13 | 2.5 2.0 3.6 14.3 11.4 20.5 | mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to | + 200 | °C |

MD3250,A,F,AF MD3251,A,F,AF MQ3251

MD3250,A MD3251,A CASE 654-07, STYLE 1

MD3250F,AF MD3251F,AF CASE 610A-04, STYLE 1

MQ3251 CASE 607-04, STYLE 1

DUAL AMPLIFIER TRANSISTOR

PNP SILICON

THERMAL CHARACTERISTICS

| Characteristic | | Symbol | One Die | All Die Equal Power | Unit |
|---|--|----------------------|------------------------|------------------------|------|
| Thermal Resistance, Junction to Case | MD3251,A, MD3251,A MD3250F,AF, MD3251F,AF MQ3251 | RAJC | 97 175 195 | 70 87.5 48.8 | °C/W |
| Thermal Resistance, Junction to Ambient | MD3250,A, MD3251,A MD3250F,AF, MD3251F,AF MO3251 | R _{BJA} (1) | 304 500 438 | 280 438 292 | °C/W |
| | | | Junction to Ambient | Junction to Case | |
| Coupling Factors | MD3250,A, MD3251,A MD3250F,AF, MD3251F,AF MQ3251 (Q1-Q2) (Q1-Q3 or Q1-Q4) | | 84 75 57 55 | 44 0 0 | % |

⁽¹⁾ Raja is measured with the device soldered into a typical printed circuit board.

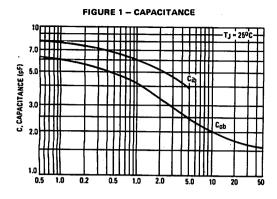
| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------|-----|-----|----------|--------------|
| OFF CHARACTERISTICS | | | 1 | | 1 |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, IB = 0) | V(BR)CEO | 40 | T- | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 50 | - | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | _ | Vdc |
| Collector Cutoff Current {VCB = 40 Vdc, IE = 0} (VCB = 40 Vdc, IE = 0, TA = 150°C) | ІСВО | | = | 10 10 | nAdc µAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | [EBO | _ | _ | 10 | nAde |

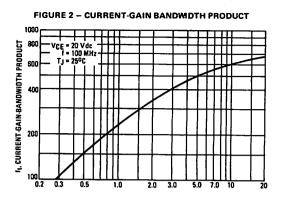
MD3250,A,F,AF, MD3251,A,F,AF, MQ3251

| ELECTRICAL CHARACTERISTICS (continued) (| 1A - 25 6 6111000 61110 | | M/2 | Turn | Max | Unit |
|---|--------------------------------|--|----------|----------|------------|------|
| Characteristic | | Symbol | Min | Тур | IAIRX | Oint |
| ON CHARACTERISTICS(2) | | | | | | |
| DC Current Gain | MADOOFO A E AE | hFE | 25 | 75 | | - (|
| (IC = 10 μ Adc, VCE = 5.0 Vdc) | MD3250,A,F,AF MD3251,A,F,AF | | 25 50 | 100 | _ | |
| | ור, ו,ר,ו טבנטווו | | 50 | 100 | i | |
| $(I_C = 100 \mu Adc, V_{CE} = 5.0 Vdc)$ | MD3250,A,F,AF | | 50 | 82 | 150 | |
| | MD3251,A,F,AF | | 80 | 170 | 300 | |
| | MQ3251 | | 80 | 170 | _ | 1 |
| (I _C = 100 μAdc, V _{CE} = 5.0 Vdc, T _A = -55°C) | MD3250,A,F,AF | 1 | 25 | 35 | _ | |
| (iC = 100 hade, ACE = 2:0 Age, 1A = -22 C) | MD3251,A,F,AF | 1 | 50 | 75 | _ | } |
| | | | | | | |
| (IC = 1.0 mAdc, VCE = 5.0 Vdc) | MD3250,A,F,AF | | 50 | 87 | 150 | |
| | MD3251,A,F,AF | | 100 | 180 | 300 | · · |
| | MQ3251 | | 100 | 180 | _ | |
| (IC = 10 mAdc, VCE = 5.0 Vdc) | MD3250,A,F,AF | | 50 | 92 | _ | [|
| "C is united iff and igni | MD3251,A,F,AF | | 100 | 190 | _ |] , |
| | MQ3251 | | 100 | 190 | 300 | |
| | | | 45 | | | |
| (IC = 50 mAdc, VCE = 5.0 Vdc) | MD3250,A,F,AF | | 15 30 | 50 90 | _ | |
| | MD3251,A,F,AF MQ3251 | | 30 | 90 | _ | 1 |
| | 14143231 | V | - 00 | - | | Vdc |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | | VCE(sat) | _ | 0.11 | 0.25 | Vac |
| (IC = 50 mAdc, IB = 5.0 mAdc) | | | _ | 0.18 | 0.5 | , |
| Base-Emitter Saturation Voltage | | V _{BE(sat)} | | | | Vdc |
| (IC = 10 mAdc, Ig = 1.0 mAdc) | | , DE(881) | 0.6 | 0.78 | 0.9 | 1 |
| (IC = 50 mAdc, IB = 5.0 mAdc) | • | 1 | _ | 0.88 | 1.2 | |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product | | ft | | | | MHz |
| (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz) | MD3250,A,F,AF | ' | 200 | 600 | - | |
| 32 | MD3251,A,F,AF | | 250 | 600 | - | 1 |
| | MQ3251 | | 300 | 600 | | |
| Output Capacitance | | Cobo | _ | 2.5 | 6.0 | pF |
| (VCB = 5.0 Vdc, IE = 0, f = 100 kHz) | | 1 | | | | |
| Input Capacitance | | Cibo | - | 6.0 | 8.0 | pF |
| (V _{BE} = 1.0 Vdc, I _C = 0, f = 100 kHz) | | | | | | L |
| MATCHING CHARACTERISTICS (MD3250,A,F,AF & | MD3251,A,F,AF ONLY | <u>" </u> | | | | 1 |
| DC Current Gain Ratio(3) | | hFE1/hFE2 | | | | _ |
| (IC = 100 μAdc, VCE = 5.0 Vdc) | | | 0.9 | - | 1.0 1.0 | l |
| (I _C = 1.0 mAdc, V _{CE} = 5.0 Vdc) | | 1 | 0.9 | | 1.0 | |
| Base-Emitter Voltage Differential | | VBE1-VBE2 | | _ | 3.0 | mVdc |
| (IC = 100 µAdc, VCE = 5.0 Vdc) | | | | = | 5.0 | |
| (IC = 10 µAdc, VCE = 5.0 Vdc) (IC = 10 mAdc, VCE = 5.0 Vdc) | | | _ | <u> </u> | 5.0 | |
| | omporatura | AlVor-Moral | | | | mVdc |
| Base-Emitter Voltage Differential Change Due to T (IC = 100 µAdc, VCE = 5.0 Vdc, TA = -55 to | | ΔίV _{BE1} /V _{BE2} | l _ | _ | 0.8 | "" |
| (IC = 100 µAdc, VCE = 5.0 Vdc, TA = -55 to - | | | l _ | _ | 1.0 |] |

⁽²⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%. (3) The lowest hFE reading is taken as hFE1 for this ratio.

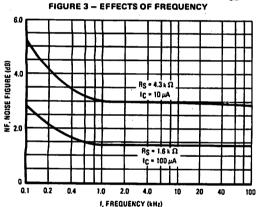
MD3250,A,F,AF, MD3251,A,F,AF, MQ3251

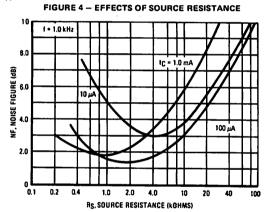


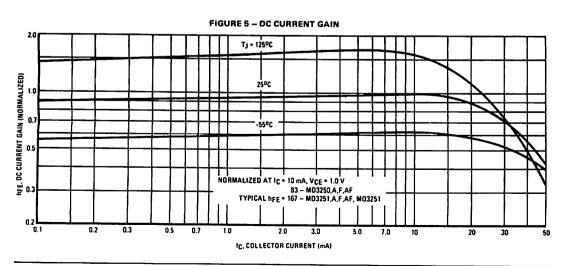


NOISE FIGURE VARIATIONS

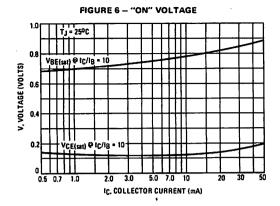
(V_{CE} = 6.0 V, T_A = 25°C)

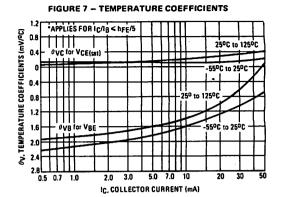


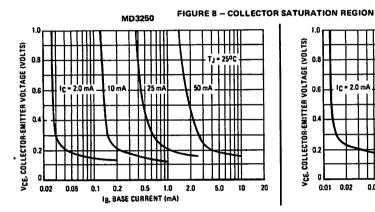


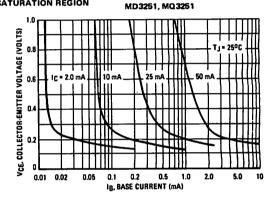


MD3250,A,F,AF, MD3251,A,F,AF, MQ3251









MAXIMUM RATINGS

| | | | | | | |
|---|-----------------------------------|-------------|----------------------------|----------------|--|------|
| Rating | Rating Symbol Value | | Unit | | | |
| Collector-Emitter Voltage | VCEO | 3 | 0 | Vdc | | |
| Collector-Base Voltage | VCBO | 6 | 0 | Vdc | | |
| Emitter-Base Voltage | VEBO | 5.0 | | 5.0 | | Vdc |
| Collector Current — Continuous | -C | 500 | | 500 | | mAdc |
| | | One Die | Both Die Equal Power | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 575 3.29 | 625 3.57 | mW mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.8 10.3 | 2.5 14.3 | Watts mW/°C | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | က | | |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | One Die | Both Die Equal Power | Unit |
|--|----------------------|------------------------|-------------------------|------|
| Thermal Resistance, Junction to Case | ReJC | 97 | 70 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 304 | 280 | °C/W |
| | | Junction to Ambient | Junction to Case | |
| Coupling Factors | | 84 | 44 | % |

MD3409 MD3410

CASE 654-07, STYLE 1

DUAL

AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MD2218 for graphs.

(1) R_{BJA} is measured with the device soldered into a typical printed circuit board.

| | ELECTRICAL | CHARACTERISTICS (TA | x = 25°C unless | otherwise noted.) |
|--|------------|---------------------|-----------------|-------------------|
|--|------------|---------------------|-----------------|-------------------|

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|------------------------------------|----------------------|----------------------|--------------------------|--------------|
| OFF CHARACTERISTICS | - | | | • | |
| Collector-Emitter Breakdown Voltage (I _C = 10 µAdc, I _B = 0) | V(BR)CEO | 30 | - | | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | V(BR)CBO | 60 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 50 Vdc, I _E = 0) (V _{CB} = 50 Vdc, I _E = 0, T _A = 150°C) | ІСВО | = | = | 10 10 | nAdc µAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | IEBO | _ | | 10 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(2) | hFE | 20 30 40 50 | 40 50 60 65 | 100 120 160 200 | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | V _{CE(sat)} | _ | 0.09 | 0.15 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | V _{BE(sat)} | - | 0.7 | 0.85 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | • | | • |
| Current-Gain — Bandwidth Product (IC = 20 mAdc, VCE = 20 Vdc, f = 100 MHz) | fΤ | 200 | 250 | - | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | Cobo | _ | 3.5 | 8.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = 0, f = 1.0 MHz) | Cibo | _ | 15 | 25 | pF |
| MATCHING CHARACTERISTICS | | | 1 | | |
| Base-Emitter Voltage Differential Change Due to Temperature (IC = 100 µAdc, VCE = 10 Vdc, MD3409 TA = −55°C to +25°C) MD3410 (IC = 100 µAdc, VCE = 10 Vdc, MD3409 TA = +25°C to +125°C) MD3410 | V _{BE1} -V _{BE2} | _ _ _ | | 1.6 0.8 2.0 1.0 | mVdc |

(2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MD3467,F MQ3467

MD3467
CASE 654-07, STYLE 1
MD3467F
CASE 610A-04, STYLE 1
MQ3467
CASE 607-04, STYLE 1
DUAL
AMPLIFIER TRANSISTOR
PNP SILICON

MAXIMUM RATINGS

| MAXIMUM NATINGS | | | | | |
|---|---------|----------------------|---------|------------------------|-------|
| Rating | | Symbol | Va | lue | Unit |
| Collector-Emitter Voltage | , | VCEO | 4 | 0 | Vdc |
| Collector-Base Voltage | | V _{CBO} | 4 | 0 | Vdc |
| Emitter-Base Voltage | | VEBO | 5 | .0 | Vdc |
| Collector Current — Cont | tinuous | lc | 1 | .5 | Adc |
| | | | One Die | All Die Equal Power | |
| Total Device Dissipation @ TA = 25°C | | PD | | | mW |
| ,0 ., | MD3467 | | 600 | 650 | |
| | MD3467F | | 350 | 400 | |
| | MQ3467 | | 400 | 600 | * |
| Derate above 25°C | | | | | mW/°C |
| | MD3467 | | 3.42 | 3.7 | |
| | MD3467F | ! | 2.0 | 2.28 | ì |
| | MQ3467 | | 2.28 | 3.42 | |
| Total Device Dissipation @ T _C = 25°C | | PD | | | Watts |
| , | MD3467 | | 2.1 | 3.0 | ľ |
| | MD3467F | | 1.25 | 2.5 | |
| | MQ3467 | | 1.0 | 4.0 | |
| Derate above 25°C | | | | | mW/°C |
| | MD3467 | | 12 | 17.2 | |
| | MD3467F | | 7.15 | 14.3 | |
| | MQ3467 | | 5.71 | 22.8 | |
| Operating and Storage J Temperature Range | unction | Tj, T _{stg} | - 65 to | + 200 | ပ္ |

THERMAL CHARACTERISTICS

| Characteristic | | Symbol | One Die | All Die Equal Power | Unit |
|---|-----------------------------|----------------------|------------------------|------------------------|------|
| Thermal Resistance, Junction to Case | MD3467 | RAJC | 83.3 | 58.3 | °C/W |
| | MD3467F MQ3467 | | 140 175 | 70 43.8 | |
| Thermal Resistance, Junction to Ambient | MD3467 MD3467F MQ3467 | R _{ØJA} (1) | 292 500 438 | 270 438 292 | *CW |
| | | | Junction to Ambient | Junction to Case | |
| Coupling Factors | MD3467 MD3467F | | 85 75 | 40 0 | % |
| | MQ3467 (Q1-Q2 | ?) 3 or Q1-Q4) | 57 55 | 0 | |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

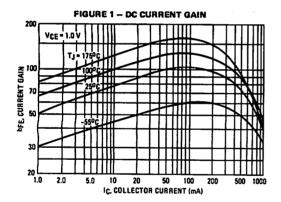
| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------|-----|-----|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, Ig = 0) | V(BR)CEO | 40 | _ | | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 40 | _ | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | - | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0, TA = 100°C) | СВО | _ | _ | 10 | μAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | lEBO | - | _ | 100 | nAdc |

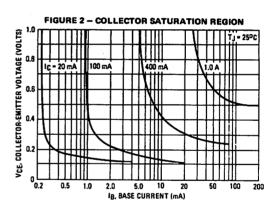
MD3467,F, MQ3467

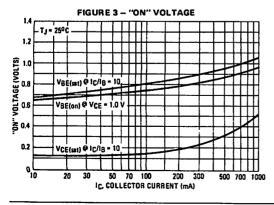
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

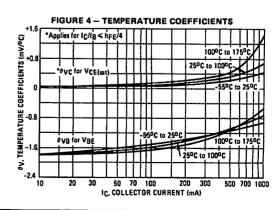
| | Characteristic | Symbol | Min | Тур | Max | Unit |
|--|---|----------------------|-----|------|-----|---------------------------------------|
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain (IC = 500 mAdc, VCE | = 1.0 Vdc) | hFE | 20 | _ | _ | |
| Collector-Emitter Saturat | | V _{CE(sat)} | _ | 0.32 | 0.5 | Vdc |
| Base-Emitter Saturation (IC = 500 mAdc, IB = | | V _{BE(sat)} | _ | 0.95 | 1.2 | Vdc |
| SMALL-SIGNAL CHARA | CTERISTICS | | | | • | · · · · · · · · · · · · · · · · · · · |
| Current-Gain — Bandwid | ith Product : 10 Vdc, f = 100 MHz) | fT | 150 | 220 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0 |), f = 140 kHz) | C _{obo} | _ | 8.5 | 20 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = | 0, f = 140 kHz) | · Cibo | _ | 22 | 80 | pF |
| SWITCHING CHARACTE | RISTICS | | | | | |
| Delay Time | (V _{CC} = 30 Vdc, V _{BE} = 2.0 Vdc, | td | | 7.0 | 10 | ns |
| Rise Time | IC = 500 mAdc, IB1 = 50 mAdc) | tr | _ | 17 | 30 | ns |
| Storage Time | (VCC = 30 Vdc, IC = 500 mAdc, | tg | _ | 58 | 80 | ns |
| Fall Time | IB1 = IB2 = 50 mAdc) | tg | | 14 | 30 | ns |

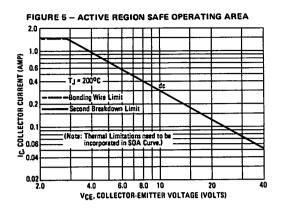
(2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

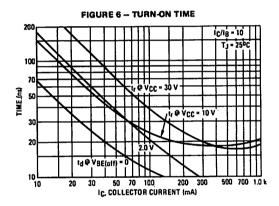


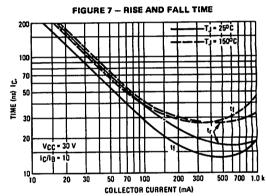


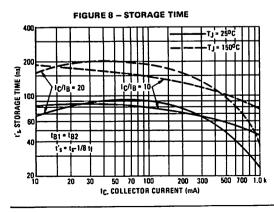


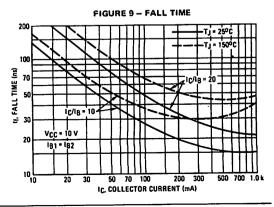




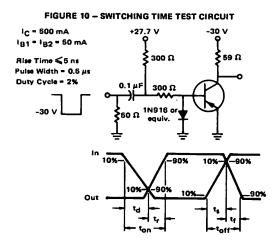


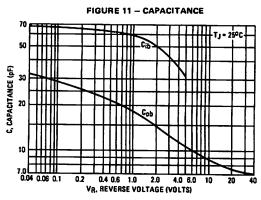






MD3467,F, MQ3467





MD3725,F MQ3725

MD3725 CASE 654-07, STYLE 1

MD3725F CASE 610A-04, STYLE 1

MQ3725 CASE 607-04, STYLE 1

DUAL AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MAXIMUM HATINGS | Combal | | lue | Unit |
|---|----------------------|---------|------------------------|----------|
| Rating | Symbol | | | |
| Collector-Emitter Voltage | VCEO | | Vdc | |
| Collector-Base Voltage | VCBO | 6 | 35 | Vdc |
| Emitter-Base Voltage | VEBO | 6 | i.0 | Vdc |
| Collector Current — Continuous | lc | 1 | .0 | Adc |
| | | One Die | All Die Equal Power | |
| Total Device Dissipation @ TA = 25°C | PD | | | mW |
| MD3725 | - 1 - 1 | 600 | 650 | |
| MD3725F | 1 : 1 | 350 | 400 | ĺ |
| MQ3725 | - [| 400 | 600 | \ |
| Derate above 25°C | 1 1 | | l | mW/°C |
| MD3725 | 1 | 3.42 | 3.7 | |
| MD3725F | 1 | 2.0 | 2.28 | ĺ |
| MQ3725 | | 2.28 | 3.42 | |
| Total Device Dissipation | PD | - | | Watts |
| @ T _C = 25°C | | | 1 | |
| MD3725 | | 2.1 | 3.0 | l |
| MD3725F | | 1.25 | 2.5 | í |
| MQ3725 | i i | 1.0 | 4.0 | |
| Derate above 25°C | 1 1 | | | mW/°C |
| MD3725 | | 12 | 17.2 | |
| MD3725F | | 7.15 | 14.3 | |
| MQ3725 | | 5.71 | 22.8 | L |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 t | °C | |

THERMAL CHARACTERISTICS

| Characteristic | | Symbol | One Die | Ali Die Equal Power | Unit |
|---|-----------------------------------|----------------------|------------------------|------------------------|------|
| Thermal Resistance, Junction to Case | MD3725 MD3725F MQ3725 | R [®] C | 83.3 140 175 | 58.3 70 43.8 | °C/W |
| Thermal Resistance, Junction to Ambient | MD3725 MD3725F MQ3725 | R _{ØJA} (1) | 292 500 433 | 270 438 292 | °C/W |
| | | | Junction to Ambient | Junction to Case | |
| Coupling Factor | MD3725 MD3725F MQ3725 (Q1-0 |)2))3, Q1-Q4) | 85 75 57 65 | 40 0 0 | % |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------|-----|------|------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, Ig = 0) | V(BR)CEO | 40 | _ | | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 10 µAdc, VBE = 0) MD3725F | V(BR)CES | 65 | - | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 µAdc, I _E = 0) | V(BR)CBO | 65 | | | Vdc |
| Emitter-Base Breakdown Voltage (Ig = 10 µAdc, IC = 0) | V(BR)EBO | 6.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 40 Vdc, IE = 0) (VCB = 40 Vdc, IE = 0, TA = 100°C) | ICBO | | 0.12 | 1.7 120 | μAdc μAdc |

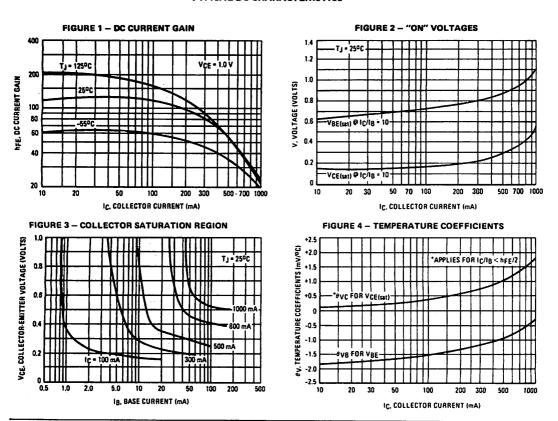
MD3765,F, MQ3725

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|----------------------|----------|--------------|--------------|------|
| ON CHARACTERISTICS(2) | | | | | • |
| DC Current Gain (I _C = 100 mAdc, V _{CE} = 1.0 Vdc) (I _C = 500 mAdc, V _{CE} = 2.0 Vdc) | hFE. | 50 30 | _ | 150 — | _ |
| Collector-Emitter Saturation Voltage (IC = 100 mAdc, Ig = 10 mAdc) (IC = 500 mAdc, Ig = 50 mAdc) | V _{CE(sat)} | = | 0.19 0.30 | 0.26 0.45 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 100 mAdc, I _B = 10 mAdc) (I _C = 500 mAdc, I _B = 50 mAdc) | V _{BE(sat)} | 0.80 | - | 0.86 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 10 Vdc, f = 100 MHz) | fT | 200 | _ | _ | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | _ | _ | 10 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = 0, f = 100 kHz) | C _{ibo} | _ | - | 65 | pF |
| SWITCHING CHARACTERISTICS | | | | | |
| Turn-On Time (V _{CC} = 30 Vdc, I_C = 500 mAdc, I_{B1} = 50 mAdc, $V_{BE(off)}$ = 3.8 Vdc) | ton | _ | 20 | 45 | ns |
| Turn-Off Time (V _{CC} = 30 Vdc, I _C = 500 mAdc, I _{B1} = I _{B2} = 50 mAdc) | ^t off | - | 50 | 75 | ns |

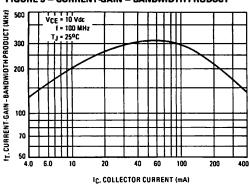
⁽²⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

TYPICAL DC CHARACTERISTICS



TYPICAL DYNAMIC CHARACTERISTICS

FIGURE 5 - CURRENT-GAIN - BANDWIDTH PRODUCT



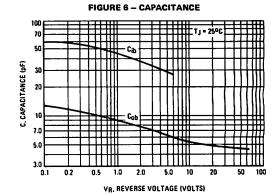


FIGURE 7 - TURN-ON TIME

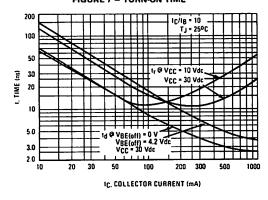


FIGURE 8 - TURN-OFF TIME

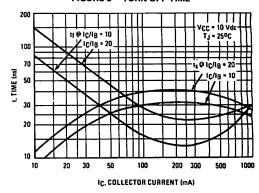


FIGURE 9 - SWITCHING TIME TEST CIRCUIT

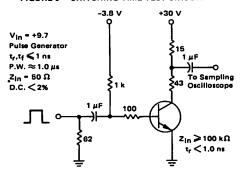
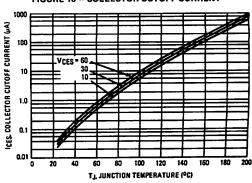


FIGURE 10 - COLLECTOR CUTOFF CURRENT



MAXIMUM RATINGS

| MAXIMUM RATINGS | | | | |
|---|----------------------|--|---|-------|
| Rating | Symbol | Ve | lue | Unit |
| Collector-Emitter Voltage | VCEO | | Vdc | |
| Collector-Base Voltage | VCBO | | 40 | Vdc |
| Emitter-Base Voltage | VEBO | Ę | 5.0 | Vdc |
| Collector Current — Continuous | ĵ. | 1 | 1.5 | Adc |
| | | One Die | All Die Equal Power | |
| Total Device Dissipation | PD | | | mW |
| @ T _A = 25°C MD3762 MD3762F MQ3762 Derate above 25°C MD3762 MD3762F MQ3762F | | 600 350 400 3.42 2.0 2.28 | 650 400 600 3.7 2.28 3.42 | mW/°C |
| Total Device Dissipation @ Tc = 25°C | PD | | | Watts |
| MD3762 MD3762F MQ3762 Derate above 25°C MD3762 MD3762F MQ3762F | | 2.1 1.25 1.0 12 7.15 5.71 | 3.0 2.5 4.0 17.2 14.3 22.8 | mW/°C |
| Operating and Storage Junction Temperature Range | Tj, T _{stg} | -65 t | o +200 | °C. |

MD3762,F MQ3762

MD3762 CASE 654-07, STYLE 1

MD3762F CASE 610A-04, STYLE 1

MQ3762 CASE 607-04, STYLE 1

DUAL AMPLIFIER TRANSISTOR

PNP SILICON

THERMAL CHARACTERISTICS

| Characteristic | | Symbol | One Die | All Die Equal Power | Unit |
|---|-----------------------------------|----------------------|------------------------|------------------------|------|
| Thermal Resistance, Junction to Case | MD3762 MD3762F MQ3762 | Reic | 83.3 140 175 | 58.3 70. 43.8 | °C/W |
| Thermal Resistance, Junction to Ambient | MD3762 MD3762F MQ3762 | R _{ØJA} (1) | 292 500 438 | 270 438 292 | •c⁄w |
| | | | Junction to Ambient | Junction to Case | |
| Coupling Factors | MD3762 MD3762F MQ3762 (Q1-Q | 12) 13, Q1-Q4) | 85 75 57 55 | 40 0 0 | % |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------|-----|-----|-----------|--------------|
| OFF CHARACTERISTICS | | | | • | |
| Collector-Emitter Breakdown Voltage(2) (I _C = 10 mAdc, I _B = 0) | V(BR)CEO | 40 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 40 | _ | - | Vdc |
| (IE = 10 µAdc, IC = 0) | V(BR)EBO | 5.0 | _ | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 30 Vdc, I _E = 0) (V _{CB} = 30 Vdc, I _E = 0, T _A = 100°C) | ІСВО | _ | = | 100 10 | nAdc μAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, I _C = 0) | IEBO | - | | 100 | nAdc |

MD3762,F, MQ3762

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| | Characteristic | Symbol | Min | Тур | Max | Unit |
|---|--|----------------------|-----|------|-----|------|
| ON CHARACTERISTICS(2 | 2) | | - | | | |
| DC Current Gain (IC = 1.0 Adc, VCE = 2 | 2.0 Vdc) | hFE | 20 | 40 | _ | - |
| Collector-Emitter Saturati | • | V _{CE(sat)} | - | 0.52 | 1.0 | Vdc |
| Base-Emitter Saturation V (IC = 1.0 Adc, IB = 0.1 | | V _{BE(sat)} | _ | 1.05 | 1.4 | Vdc |
| SMALL-SIGNAL CHARAC | TERISTICS | | | | | |
| Current-Gain — Bandwidt (IC = 50 mAdc, VCE = | | ſΤ | 150 | 220 | - | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, | , f = 140 kHz) | C _{obo} | _ | 8.5 | 20 | ρF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0 |), f = 140 kHz) | C _{ibo} | _ | 22 | 80 | pF |
| SWITCHING CHARACTER | RISTICS | | | | | |
| Delay Time | (VCC = 30 Vdc, VBE(off) = 2.0 Vdc, | t _d | _ | 5.0 | 10 | ns |
| Rise Time | IC = 1.0 Adc, IB1 = 100 mAdc) | t _r | - | 18 | 30 | ns |
| Storage Time | (V _{CC} = 30 Vdc, I _C = 1.0 Adc, | ts | _ | 45 | 80 | ns |
| Fall Time | IB1 = IB2 = 100 mAdc) | tf | _ | 18 | 30 | ns |

⁽²⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

FIGURE 1 - DC CURRENT GAIN

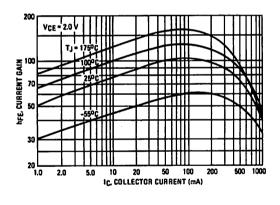
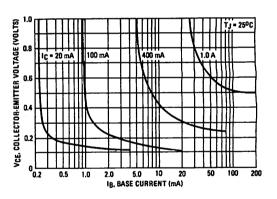
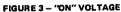


FIGURE 2 - COLLECTOR SATURATION REGION





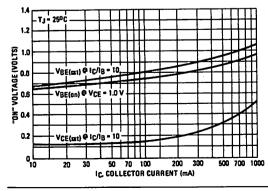
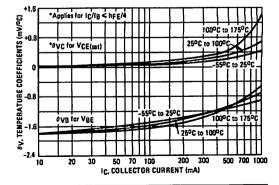
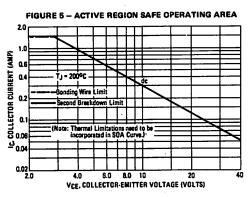
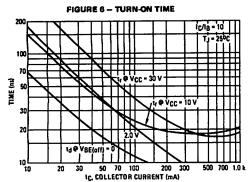


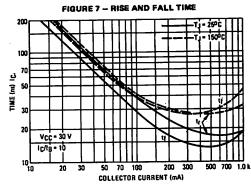
FIGURE 4 - TEMPERATURE COEFFICIENTS

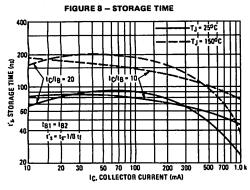


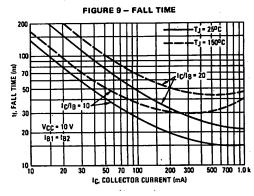
⁽³⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.

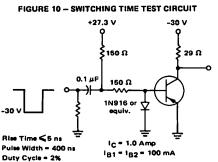


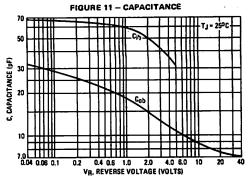












MD4260 MD4261

CASE 654-07, STYLE 1

DUAL RF AMPLIFIER

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | | Unit |
|---|-----------------------------------|-------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 1 | 12 | |
| Collector-Base Voltage | VCBO | 1 | 2 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | | Vdc |
| Collector Current — Continuous | lc | 50 | | mAdc |
| | | One Die | Both Die | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 550 3.14 | 600 3.42 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.4 8.0 | 2.0 11.4 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | °C |

THERMAL CHARACTERISTICS

| Characteristic | Junction to Ambient | Junction to Case | Unit |
|---------------------|------------------------|---------------------|------|
| Thermal Resistance | | | °C/W |
| One Die | 319 | 125 | |
| Effective, Both Die | 292 | 87.5 | |
| Coupling Factor | 83 | 40 | % |

Refer to 2N4260 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|------------|----------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 10 mAdc, IB = 0) | V(BR)CEO | 12 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | V(BR)CBO | 12 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 4.0 | _ | Vdc |
| Collector Cutoff Current (VCE = 12 Vdc, IB = 0) | ICEO | _ | 1.0 | μAdc |
| Collector Cutoff Current (VCB = 10 Vdc, IE = 0) | Ісво | _ | 10 | nAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) (I _C = 30 mAdc, V _{CE} = 2.0 Vdc) | hFE | 30 20 | 200 — | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | V _{CE(sat)} | _ | 0.3 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | V _{BE(sat)} | | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | , | | | |
| Current-Gain — Bandwidth Product (IC = 0.5 mAdc, V_{CE} = 4.0 Vdc, f = 100 MHz) (IC = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz) | ĺΤ | 1.0 1.5 | = | GHz |
| Output Capacitance (VCB = 3.0 Vdc, IE = 0, f = 100 kHz) | Cobo | _ | 2.5 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = 0, f = 100 kHz) | Cibo | _ | 2.5 | pF |
| Collector Base Time Constant (I _C = 5.0 mAdc, V _{CE} = 4.0 Vdc, f = 31.8 MHz) (I _C = 10 mAdc, V _{CE} = 10 Vdc, f = 31.8 MHz) | rb'C _C | = | 35 30 | ps |
| MATCHING CHARACTERISTICS (MD4261 only) | | | - | • |
| DC Current Gain Ratio(1) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) | hFE1/hFE2 | 0.8 | 1.0 | _ |
| Base-Emitter Voltage Differential (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) | VBE1-VBE2 | _ | 10 | mVdc |

⁽¹⁾ The lowest hee reading is taken as hee1 for this ratio.

MD5000,A,B

CASE 654-07, STYLE 1

DUAL AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | | Unit |
|--|----------------------|-------------|---------------|-------------|
| Collector-Emitter Voltage | VCEO | 15 | | Vdc |
| Collector-Base Voltage | V _{CBO} | 20 | 20 | |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc |
| Collector Current Continuous | lc | 50 | | mAdc |
| | | One Side | Both Sides | |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 300 1.7 | 400 2.3 | mW mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | | °C |

Refer to 2N3307 for graphs.

| EI ECTRICAL | CHARACTERISTICS /T | 25°C unless otherwise noted.) |
|--------------|-------------------------|-------------------------------|
| ELEC I NICAL | . CHARACTENISTICS IIA 🖴 | 25 C unless otherwise noted.) |

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|------------------------------|---|----------------|---|----------------|-------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 3.0 mAdc, IB = | = 0) | V(BR)CEO | 15 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | | V(BR)CBO | 20 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage ($I_E = 10 \mu Adc, I_C = 0$) | | V(BR)EBO | 5.0 | - | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 15 Vdc, I_E = 0) (V _{CB} = 15 Vdc, I_E = 0, T_A = 150 | °C) | ICBO | - | 1.1 | 0.010 1.0 | μAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain (I _C = 3.0 mAdc, V _{CE} = 1.0 Vdc) | | ptE | 20 | 50 | _ | 1 |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = | 1.0 mAdc) | V _{CE(sat)} | ı | 1 | 0.4 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 I | mAdc) | V _{BE(sat)} | _ | _ | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product (IC = 4.0 mAdc, VCE = 10 Vdc, f = 100 MHz) | | fŢ | 600 | 900 | - | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 140 kHz) | | C _{obo} | _ | - | 1.7 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 140 kHz) | | C _{ibo} | _ | _ | 2.0 | pF |
| Noise Figure (I _C = 1.0 mAdc, V _{CE} = 6.0 Vdc, f = 60 MHz, R _S = 400 o | hms) | NF | _ | 3.0 | 6.0 | dB |
| FUNCTIONAL TEST | | | | *************************************** | | |
| Amplifier Power Gain (IC = 6.0 mAdc, VCB = 12 Vdc, RG = RL = 50 ohms, f = | = 200 MHz) | Gpe | 15 | 20 | _ | ďΒ |
| MATCHING CHARACTERISTICS | | | | • | | |
| 10 III | MD5000 MD5000A MD5000B | hFE1/hFE2 | 0.9 0.8 | 0.7 — — | 1.0 1.0 | _ |
| 1 GE 1 | MD5000 MD5000A MD5000B | VBE1-VBE2 | - | 5.0 — — | 5.0 10 | mVdc |
| | MD5000 MD5000A MD5000B | Δ(V _{BE1} -V _{BE2}) ΔΤ _Α | _ _ _ | 10 — — | 10 20 | μV/°C |

(1) The lowest hee reading is taken as hee1 for this ratio.

MD6001,F MD6002,F MD6003,F MQ6001, MQ6002

MQ6001, MQ6002
MD6001
MD6002
MD6003
CASE 654-07, STYLE 5
MD6001F
MD6002F
MD6003F
CASE 610A-04, STYLE 1
MQ6001
MQ6002
CASE 607-04, STYLE 1
COMPLEMENTARY DUAL
GENERAL PURPOSE
TRANSISTOR
NPNPPP SILICON

MAXIMUM RATINGS

| Rating | Symbol | MD6003 MD6003F | MD6001,F MD6002,F MQ6001,2 | Unit |
|--|----------------------|---|---|----------------|
| Collector-Emitter Voltage | VCEO | | 30 | Vdc |
| Collector-Base Voltage | V _{СВО} | 50 | 60 | Vdc |
| Emitter-Base Voltage | VEBO | ! | 5.0 | Vdc |
| Collector Current — Continuous | lc | | 500 | mAdc |
| | | One Die | All Die Equal Power | |
| Total Device Dissipation @ T _A = 25°C MD6001,2,3 MD6001,2,3 MD6001,2 Derate above 25°C MD6001,2,3 MD6001,2,3 MD6001,2,3 MD6001,2,3 MD6001,2 | PD | 575 350 400 3.29 2.0 2.28 | 625 400 600 3.57 2.28 3.42 | mW/°C |
| Total Device Dissipation @ T _C = 25°C MD6001,2,3 MD6001F,2F,3F MQ6001,2 Derate above 25°C MD6001,2,3 MD6001F,2F,3F MQ6001,2 | PD | 1.8 1.0 0.9 10.3 5.71 5.13 | 2.5 2.0 3.6 14.3 11.4 20.5 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | - 65 t | to +200 | °C |

THERMAL CHARACTERISTICS

| Characteris | tic | Symbol | One Die | All Die Equal Power | Unit |
|---|---|----------------------|------------------------|------------------------|-------------|
| Thermal Resistance, Junction to Case | MD6001,2,3 MD6001F,2F,3F MQ6001,2 | RAIC | 97 175 195 | 70 87.5 48.8 | °C/W |
| Thermal Resistance, Junction to Ambient | MD6001,2,3 MD6001F,2F,3F MQ6001,2 | R _{ØJA} (1) | 304 500 438 | 280 438 292 | .c w |
| | | | Junction to Ambient | Junction to Class | |
| Coupling Factor | MD6001,2,3 MD6001F,2F,3F MQ6001,2 (Q1-Q2) | | 84 75 57 | 44 0 0 | % |
| | (Q1-Q3 or Q1-Q4) | | 55 | ŏ | |

⁽¹⁾ Raja is measured with the device soldered into a typical printed circuit board.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|----------|----------|-----|----------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, Ig = 0) | V(BR)CEO | 30 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 µAdc, I _E = 0) MD6003,F MD6001,F, MD6002,F, MQ6001, MQ6002 | V(BR)CBO | 50 60 | = | = | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | V(BR)EBO | 5.0 | _ | _ | Vdc |
| Base Cutoff Current (VCE = 30 Vdc, VBE = 3.0 Vdc) | IBEV | _ | _ | 50 30 | nAdc |

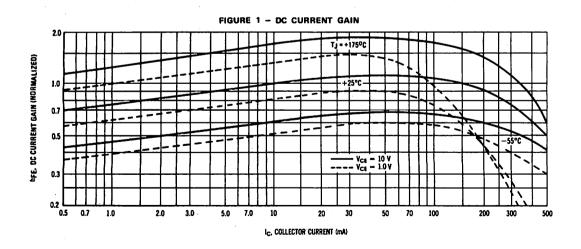
MD6001,F, MD6002,F, MD6003,F, MQ6001, MQ6002

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteris | tic | Symbol | Min | Тур | Max | Unit |
|--|--|--------|-----|-----|----------------|----------------------|
| (VCE = 50 Vdc, VEB(off) = 3.0 Vdc) | MD6003,F MD6001,F,2,F, MQ6001,2 MD6001,F,2,F, MQ6001,2 | ICEV | - | - | 30 20 30 | nAdc nAdc μAdc |
| Collector Cutoff Current (VCB = 40 Vdc, IE = 0) ON CHARACTERISTICS(2) | MD6003,F | СВО | _ | _ | 100 | пА |

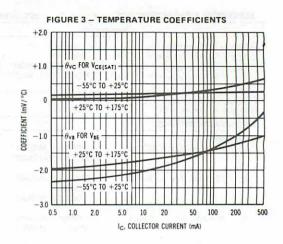
| ON CHARACTERISTICS(2) | | | | | | |
|---|----------------------------|----------------------|-----|----------|-----|-----|
| DC Current Gain | | hre | | | | _ |
| (IC = 0.1 mAdc, VCE = 10 Vdc) | MD6001,F, MQ6001 | | 20 | 80 | - | |
| | MD6002,F, MQ6002 | | 35 | - 70 | _ | |
| (IC = 1.0 mAdc, VCE = 10 Vdc) | MD6001,F, MQ6001 | | 25 | 90 | _ | |
| | MD6003,F | | 40 | 70 | _ | |
| | MQ6002,F, MQ6002 | | 50 | 100 | _ | |
| (IC = 10 mAdc, VCE = 10 Vdc) | MD6001,F, MQ6001 | | 35 | 70 | _ | |
| . = | MD6002,F, MQ6002 | | 75 | 110 | _ | |
| (Ic = 150 mAdc, VcE = 10 Vdc) | MD6001,F, MQ6001 | | 40 | _ | 120 | |
| | MD6003,F | | 70 | 110 | _ | |
| | MD6002,F, MQ6002 | | 100 | 200 | 300 | |
| (I _C = 300 mAdc, V _{CE} = 10 Vdc) | MD6001,F, MQ6001 | | 20 | _ | _ | |
| | All Other Devices | - | 30 | 90 | _ | |
| (IC = 150 mAdc, VCE = 10 Vdc) | MD6001,F, MQ6001 | | 20 | 80 | l – | |
| | MD6002,F, MQ6002 | | 50 | <u> </u> | _ | |
| Collector-Emitter Saturation Voltage | | V _{CE(sat)} | | | | Vdc |
| (IC = 150 mAdc, IB = 15 mAdc) | All Devices | Į. | | 0.3 | 0.4 | |
| (IC = 300 mAdc, IB = 30 mAdc) | MD6001, MD6002,F, MQ6002,1 | | | 0.59 | 1.4 | |
| Base-Emitter Saturation Voltage | | V _{BE(sat)} | | | | Vdc |
| (IC = 150 mAdc, IB = 15 mAdc) | All Devices | Ì | - | 1.02 | 1.3 | |
| (IC = 300 mAdc, IB = 30 mAdc) | MD6001, MD6002,F, MQ6001,2 | l | | 1.25 | 2.0 | |

(2) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.



NF, NOISE FIGURE (dB)

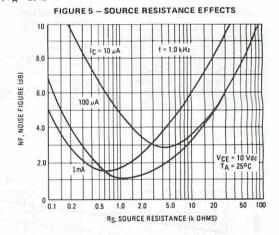
FIGURE 2 - "ON" VOLTAGES 2.0 1.6 ON" VOLTAGE (VOLTS) 1.2 0.8 VAE @ VCE $= 1.0 \, \text{V}$ 0.4 VCE(SAT) @ Ic/Is 10 0 0.5 1.0 2.0 5.0 10 20 50 100 200 500 Ic. COLLECTOR CURRENT (mA)

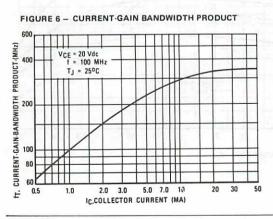


NOISE FIGURE VCE = 10 V, TA = 25°C

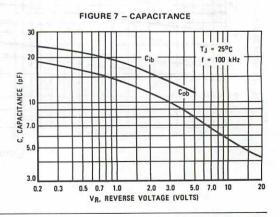
6.0 VCE = 10 Vdc TA = 25°C 5.0 4.0 $=4.7 k\Omega$ 3.0 $I_C = 1.0 \text{ mA}$ $R_S = 0.7 \text{ k}\Omega$ 2.0 1.0 $I_C = 100 \mu A$ $R_S = 1.2 k\Omega$ 0 2.0 5.0 10 50 0.2 0.5 1.0 0.1

FIGURE 4 - FREQUENCY EFFECTS

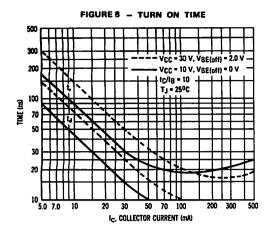


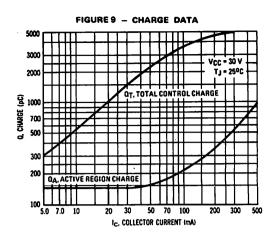


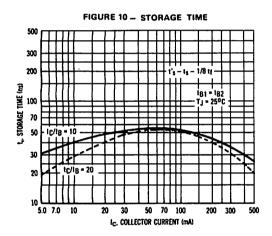
f. FREQUENCY (kHz)

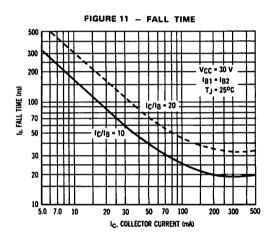


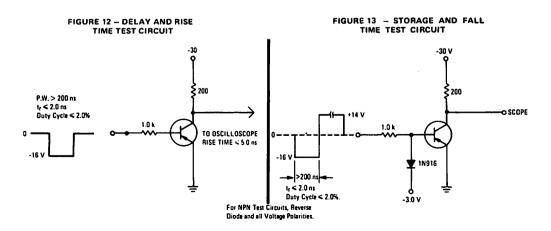
MD6001,F, MD6002,F, MD6003,F, MQ6001, MQ6002











MD7000

CASE 654-07, STYLE 1

DUAL
GENERAL PURPOSE
TRANSISTOR

NPN SILICON

Refer to MD2218 for graphs.

MAXIMUM RATINGS

| Rating | Symbol | Value | | Unit |
|--|-----------------------------------|-------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 3 | 30 | Vdc |
| Collector-Base Voltage | V _{CBO} | 5 | 50 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc |
| Collector Current — Continuous | lc | 5 | 00 | mAdc |
| | | One Die | Both Die | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 575 3.29 | 625 3.57 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.8 10.3 | 2.5 14.3 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | One Die | Both Die | Unit |
|---|--------|------------------------|---------------------|------|
| Thermal Resistance, Junction to Case | ReJC | 97 | 70 | °C/W |
| Thermal Resistence, Junction to ReJA(1) Ambient | | 304 | 280 | °C/W |
| | | Junction to Ambient | Junction to Case | |
| Coupling Factor | | 84 | 44 | % |

⁽¹⁾ Raja is measured with the device soldered into a typical printed circuit board.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------------------|----------------|----------------|-------------|------|
| OFF CHARACTERISTICS | | | | · | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, Ig = 0) | V(BR)CEO | 30 | | | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 µAdc, I _E = 0) | V(BR)CBO | 50 | | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 40 Vdc, I _E = 0) | ICBO | | _ | 100 | nAdc |
| ON CHARACTERISTICS | | | • | | |
| DC Current Gain(2) (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 150 mAdc, V _{CE} = 10 Vdc) (I _C = 300 mAdc, V _{CE} = 10 Vdc) | hFE | 40 70 30 | 60 80 50 | _ _ _ | _ |
| Collector-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc) | VCE(sat) | - | 0.2 | 0.4 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc) | V _{BE(sat)} | - | 0.95 | 1.3 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (I _C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz) | fī | 200 | 250 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | _ | 3.5 | 8.0 | pF |
| Input Capacitance (VEB = 2.0 Vdc, I _C = 0, f = 100 kHz) | C _{ibo} | _ | 15 | 30 | pF |

⁽²⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MAYIMI IM PATINGS

| MAXIMUM RATINGS | | | | |
|---|-----------------------------------|--|---|----------------|
| Rating | Symbol | Value | | Unit |
| Collector-Emitter Voltage | VCEO | 3 | 30 | |
| Collector-Base Voltage | VCBO | 5 | 0 | Vdc |
| Emitter-Base Voltage | VEBO | 5. | .0 | Vdc |
| Collector Current — Continuous | lc | 60 | 00 | mAdc |
| | | One Die | All Die | |
| Total Device Dissipation @ T _A = 25°C MD7001 MD7001F MQ7001 Derate above 25°C MD7001 MD7001F MQ7001F MQ7001 | PD | 600 350 400 3.42 2.0 2.28 | 650 400 600 3.7 2.28 3.42 | mW/°C |
| Total Device Dissipation @ T _C = 25°C MD7001 MD7001F MQ7001 Derate above 25°C MD7001 MD7001F MQ7001F MQ7001F | PD | 2.1 1.25 1.0 12 7.15 5.71 | 3.8 2.5 4.0 17.2 14.3 22.8 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 65 to | + 200 | °C |

MD7001,F MQ7001

MD7001 CASE 654-07, STYLE 1

MD7001F CASE 610A-04, STYLE 1

MQ7001 CASE 607-04, STYLE 1

DUAL AMPLIFIER TRANSISTOR

PNP SILICON

THERMAL CHARACTERISTICS

| Characteristic | | Symbol | One Die | All Die Equal Power | Unit |
|---|-----------------------------------|----------------------|------------------------|------------------------|------|
| Thermal Resistance, Junction to Case | MD7001 MD7001F | RAJC | 83.3 140 | 58.3 70 | °C/W |
| | MQ7001 | | 175 | 43.8 | |
| Thermal Resistance, Junction to Ambient | MD7001 MD7001F MQ7001 | R _{ØJA} (1) | 292 500 438 | 270 438 292 | °CAV |
| | | | Junction to Ambient | Junction to Case | |
| Coupling Factor | MD7001 MD7001F MQ7001 (Q1-0 |)2))3 or Q1-Q4) | 85 75 57 55 | 40 0 0 | % |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|----------------------|----------------|----------------|--------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (I _C = 10 mAdc, I _B = 0) | V(BR)CEO | 30 | _ | 1 | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 50 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | V(BR)EBO | 5.0 | _ | - | Vdc |
| Collector Cutoff Current (VCB = 40 Vdc, IE = 0) | Ісво | _ | - | 100 | nAdc |
| ON CHARACTERISTICS(2) | | | | | |
| DC Current Gain (IC = 1.0 mAdc, V _{CE} = 10 Vdc) (IC = 150 mAdc, V _{CE} = 10 Vdc) (IC = 300 mAdc, V _{CE} = 10 Vdc) | hFE | 40 70 30 | 50 90 60 | - - | _ |
| Collector-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc) | V _{CE(sat)} | _ | 0.25 | 0.4 | Vdc |

MD7001,F, MQ7001

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------------------|-----|------|-----|------|
| Base-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) | V _{BE(sat)} | _ | 0.88 | 1.3 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product(2) (I _C = 20 mAdc, V _{CE} = 20 Vdc, f = 100 MHz) | fT | 200 | 320 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | C _{obo} | _ | 5.8 | 8.0 | ρF |
| Input Capacitance (VBE = 2.0 Vdc, I_C = 0, f = 100 kHz) | C _{ibo} | _ | 16 | 30 | pF |

⁽²⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MAXIMUM RATINGS

| MAXIMUM RATINGS | | _ | | | | | | |
|--|-----------------------------------|-------------|-------------------------|----------------|--|-----|--|------|
| Rating | Symbol | V | Unit | | | | | |
| Collector-Emitter Voltage | VCEO | 40 | | Vdc | | | | |
| Collector-Base Voltage | VCBO | 50 | | 50 | | Vdc | | |
| Emitter-Base Voltage | VEBO | 5.0 | | 5.0 | | 5.0 | | Vdc |
| Collector Current — Continuous | lc | 30 | | 30 | | 30 | | mAdc |
| | _ | One Die | Both Die Equal Power | | | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 575 3.29 | 625 3.57 | mW mW/°C | | | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.8 10.3 | 2.5 14.3 | Watts mW/°C | | | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 t | o +200 | °C | | | | |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | One Die | Both Die Equal Power | Unit |
|--|----------------------|------------------------|-------------------------|------|
| Thermal Resistance, Junction to Case | RejC | 97 | 70 | °C/W |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 304 | 280 | °C/W |
| | • | Junction to Ambient | Junction to Case | |
| Coupling Factors | | 84 | 44 | % |

(1) ROJA is measured with the device soldered into a typical printed circuit board.

MD7002,A,B

CASE 654-07, STYLE 1
DUAL

AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N2919 for graphs.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|----------------------|--------------|------------|------------|------|
| OFF CHARACTERISTICS | | | | | • |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, IB = 0) | V(BR)CEO | 40 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | V(BR)CBO | 50 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 5.0 | | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 30 Vdc, I _E = 0) | ІСВО | _ | _ | 100 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(2) (I _C = 100 µAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc) | hFE | 40 50 | 130 170 | _ | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | V _{CE(sat)} | _ | 0.2 | 0.35 | Vđc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | V _{BE(sat)} | | 0.8 | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product(2) (IC = 5.0 mAdc, VCE = 20 Vdc, f = 100 MHz) | fτ | 200 | 260 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 100 kHz) | Cobo | _ | 2.6 | 6.0 | pF |
| Input Capacitance (VBE = 2.0 Vdc, I _C = 0, f = 100 kHz) | C _{ibo} | _ | 2.3 | 8.0 | pF |
| MATCHING CHARACTERISTICS | | | | • | |
| DC Current Gain Ratio(3) (I _C = 100 μAdc, V _{CE} = 10 Vdc) MD7002A MD7002B | hFE1/hFE2 | 0.75 0.85 | = | 1.0 1.0 | _ |
| Base-Emitter Voltage Differential (IC = 100 μAdc, VCE = 10 Vdc) MD7002A MD7002B | VBE1-VBE2 | = | | 25 15 | mVdc |

⁽²⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

⁽³⁾ The lowest hee reading is taken as hee1 for this ratio.

MD7003,A,B,F,AF MQ7003

MD7003,A,B CASE 654-07, STYLE 1

MD7003F,AF CASE 610A-04, STYLE 1

MQ7003 CASE 607-04, STYLE 1

DUAL AMPLIFIER TRANSISTOR

PNP SILICON

Refer to 2N3810 for curves.

MAXIMUM RATINGS

| MAXIMUM RATINGS | | | | |
|---|-----------------------------------|-------------|------------------------|-------|
| Rating | Symbol | Va | Unit | |
| Collector-Emitter Voltage | VCEO | 40 | | Vdc |
| Collector-Base Voltage | VCBO | | 50 | Vdc |
| Emitter-Base Voltage | VEBO | 5 | 5.0 | Vdc |
| Collector Current — Continuous | lc | | 50 | mAdc |
| | | One Die | All Die Equal Power | |
| Total Device Dissipation @ TA = 25°C | PD | | | mW |
| MD7003,A,B | | 550 | 600 | |
| MD7003F,AF | l i | 350 | 400 | |
| MQ7003 | | 400 | 600 | |
| Derate above 25°C | İ | | | mW/°C |
| MD7003,A,B | | 3.14 | 3.42 | |
| MD7003F,AF | 1 1 | 2.0 | 2.28 | |
| MQ7003 | | 2.28 | 3.42 | |
| Total Device Dissipation | PD | | | Watts |
| @ T _C = 25℃ | | | | |
| MD7003,A,B | | 1.4 | 2.0 | |
| MD7003F,AF | | 0.7 | 1.4 | |
| MQ7003 | | 0.7 | 2.8 | |
| Derate above 25°C | | | | mW/°C |
| MD7003,A,B | | 8.0 | 11.4 | |
| MD7003F,AF | | 4.0 | 8.0 | 1 |
| MQ7003 | | 4.0 | 16 | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | | င့ |

THERMAL CHARACTERISTICS

| Characteristic | | Symbol | One Die | All Die Equal Power | Unit |
|---|--|----------------------|------------------------|------------------------|------|
| Thermal Resistance, Junction to Case | MD7003,A,B MD7003F,AF MQ7003 | R _{WC} | 125 250 250 | 87.5 125 62.6 | °C/W |
| Thermal Resistance, Junction to Ambient | MD7003,A,B MD7003F,AF MQ7003 | R _{ØJA} (1) | 319 500 438 | 292 438 292 | °C/W |
| | | | Junction to Ambient | Junction to Case | |
| Coupling Factor | MD7003,A,B MD7003F,AF MQ7003 (Q1-Q2) | or Q1-Q4) | 83 75 57 55 | 40 0 0 | % |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------|----------|------------|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, IB = 0) | V(BR)CEO | 40 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 µAdc, I _E = 0) | V(BR)CBO | 50 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | V(BR)EBO | 5.0 | | | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0) | ІСВО | _ | · ·- | 100 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(2) (IC = 100 µAdc, VCE = 10 Vdc) (IC = 10 mAdc, VCE = 10 Vdc) | hFE | 40 50 | 350 350 | _ | _ |

MD7003,A,B,F,AF, MQ7003

| Symbol | Min | Тур | Max | Unit |
|----------------------|-----------------------------------|--|---|--|
| VCE(sat) | _ | 0.25 | 0.35 | Vdc |
| V _{BE(sat)} | - | 0.6 | 1.0 | Vdc |
| | | | | |
| fŢ | 200 | 300 | | MHz |
| C _{obo} | _ | 3.0 | 6.0 | pF |
| C _{ibo} | - | 2.0 | - 8.0 | pF |
| NF | _ | 2.0 | _ | dB |
| • | | • | · | |
| | VCE(sat) VBE(sat) fT Cobo Cibo | VCE(sat) — VBE(sat) — fT 200 Cobo — Cibo — | VCE(sat) — 0.25 VBE(sat) — 0.6 fT 200 300 Cobo — 3.0 Cibo — 2.0 | VCE(sat) — 0.25 0.35 VBE(sat) — 0.6 1.0 fT 200 300 — Cobo — 3.0 6.0 Cibo — 2.0 8.0 |

| DC Current Gain Ratio(3) (IC = 100 μAdc, VCE = 10 Vdc) | MD7003A,AF MD7003B | hFE1/hFE2 | 0.75 0.85 | _ | 1.0 1.0 | _ |
|---|-----------------------|-----------|--------------|---|------------|----|
| Base-Emitter Voltage Differential (IC = 100 μAdc, VCE = 10 Vdc) | MD7003A,AF MD7003B | VBE1-VBE2 | - | | 25 15 | mV |

⁽²⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

⁽³⁾ The lowest hee reading is taken as hee1 for this ratio.

MD7007,A,B,F,BF MQ7007

MD7007,A,B CASE 654-07, STYLE 1

MD7007F,BF CASE 610A-04, STYLE 1

MQ7007 CASE 607-04, STYLE 1

DUAL AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| MAXIMUM HATINGS | | | | |
|---|----------|---------------------|------------------------|-------|
| Rating | Symbol | Va | Unit | |
| Collector-Emitter Voltage | VCEO | 40 | | Vdc |
| Collector-Base Voltage | VCBO | | 50 | Vdc |
| Emitter-Base Voltage | VEBO | 5 | .0 | Vdc |
| Collector Current — Continuous | lc | 2 | 00 | mAdc |
| | | One Die | All Die Equal Power | |
| Total Device Dissipation | PD | | | mW |
| @ T _A = 25°C MD7007,A,B MD7007F,BF MQ7007 | | 575 350 400 | 625 400 600 | |
| Derate above 25°C MD7007,A,B MD7007F,BF MQ7007 | | 3.29 2.0 2.28 | 3.57 2.28 3.42 | mW/°C |
| Total Device Dissipation @ T _C = 25°C | PD | - | | Watts |
| MD7007,A,B MD7007F,BF MQ7007 Derate above 25°C MD7007,A,B | | 1.8 1.0 0.9 | 2.5 2.0 3.6 | mW/°C |
| MD7007F,BF MQ7007 | | 5.71 5.13 | 11.4 20.5 | |
| Operating and Storage Junction Temperature Range | TJ, Tstg | -65 to | o +200 | °C |

THERMAL CHARACTERISTICS

| Characteristic | - | Symbol | One Die | All Die Equal Power | Unit |
|---|---|-------------------|------------------------|------------------------|------|
| Thermal Resistance, Junction to Case | MD7007,A,B MD7007F,BF MQ7007 | RAJC | 97 175 195 | 70 87.5 48.8 | °C/W |
| Thermal Resistance, Junction to Ambient | MD7007,A,B MD7007F,BF MQ7007 | Raja(1) | 304 500 438 | 280 438 292 | °C/W |
| | | | Junction to Ambient | Junction to Case | |
| Coupling Factors | MD7007,A,B MD7007F,BF MQ7007 (Q1-Q2 | ?) ? or Q1-Q4) | 84 75 57 55 | 44 0 0 | % |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

| Characteristic | Symbol | Min | Түр | Max | Unit |
|---|----------|----------------------|------------------------|----------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, Ig = 0) | V(BR)CEO | 40 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 50 | _ | | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | V(BR)EBO | 5.0 | _ | - | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0) | ІСВО | _ | | 100 | nAdc |
| ON CHARACTERISTICS(2) | | | | | |
| DC Current Gain (IC = 100 µAdc, VCE = 10 Vdc) (IC = 1.0 mAdc, VCE = 10 Vdc) (IC = 10 mAdc, VCE = 10 Vdc) (IC = 50 mAdc, VCE = 10 Vdc) | hFE | 30 30 30 15 | 110 130 75 25 | <u>-</u> | _ |

MD7007,A,B,F,BF, MQ7007

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|--------------------|----------------------|--------------|------|----------|------|
| Collector-Emitter Saturation Voltage (IC = 50 mAdc, IB = 5.0 mAdc) | | V _{CE(sat)} | - | 0.38 | 1.0 | Vdc |
| Base-Emitter Saturation Voltage (IC = 50 mAdc, Ig = 5.0 mAdc) | | V _{BE(sat)} | _ | 0.9 | 1.5 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | , | | | |
| Current-Gain — Bandwidth Product(2) (IC = 10 mAdc, VCE = 10 Vdc, f = 100 MHz) | | ÍΤ | 300 | 600 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 100 kHz) | | C _{obo} | _ | 4.0 | 8.0 | pF |
| Input Capacitance (VBE = 2.0 Vdc, I _C = 0, f = 100 kHz) | | C _{ibo} | _ | 3.8 | 10 | pF |
| MATCHING CHARACTERISTICS | | | | | | |
| DC Current Gain Ratio(3) (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) | MD7007A MD7007B | hFE1/hFE2 | 0.75 0.85 | _ | 1.0 | _ |
| Base-Emitter Voltage Differential (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) | MD7007A MD7007B | IVBE1-VBE2 | | _ | 20 10 | mVdc |

⁽²⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%. (3) The lowest hfe reading is taken as hfe1 for this ratio.

MD7021,F MQ7021

MD7021 CASE 654-07, STYLE 5

MD7021F CASE 610A-04, STYLE 1

MQ7021 CASE 607-04, STYLE 1

COMPLEMENTARY
GENERAL PURPOSE TRANSISTOR

NPN/PNP SILICON

MAXIMUM RATINGS

| MAXIMUM RATINGS | | | | |
|---|-----------------------------------|---------|------------------------|-------|
| Rating | Symbol | V. | Unit | |
| Collector-Emitter Voltage | VCEO | | Vdc | |
| Collector-Base Voltage | VCBO | | Vdc | |
| Emitter-Base Voltage | VEBO | | 5.0 | Vdc |
| Collector Current — Continuous | lc | | 50 | mAdc |
| | | One Die | All Die Equal Power | |
| Total Device Dissipation @ TA = 25°C | PD | | | mW |
| MD7021 | 1 1 | 550 | 600 | ĺ |
| MD7021F | | 350 | 400 | |
| MQ7021 | 1 1 | 400 | 600 | j |
| Derate above 25°C | | | 1 | mW/°C |
| MD7021 | | 3.14 | 3.42 | |
| MD7021F | | 2.0 | 2.28 | |
| MQ7021 | | 2.28 | 3.42 | |
| Total Device Dissipation | PD | | | Watts |
| @ T _C = 25℃ | | | | |
| MD7021 | | 1.4 | 2.0 | |
| MD7021F | - 1 - 1 | 0.7 | 1.4 | |
| MQ7021 | 1 1 | 0.7 | 2.8 | |
| Derate above 25°C | - 1 | | 1 | mW/°C |
| MD7021 | | 8.0 | 11.4 | |
| MD7021F | | 4.0 | 8.0 | |
| MQ7021 | \perp | 4.0 | 16 | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 t | o +200 | °C |

THERMAL CHARACTERISTICS

| Characteristic | | Symbol | One Die | All Die Equal Power | Unit |
|---|---------|----------------------|------------------------|------------------------|------|
| Thermal Resistance, Junction to Case | | RAIC | | | °C/W |
| | MD7021 | | 125 | 87.5 | |
| | MD7021F | | 250 | 125 | |
| | MQ7021 | | 250 | 62.6 | |
| Thermal Resistance, Junction to Ambient | | R _{BJA} (1) | | | °C/W |
| • | MD7021 | | 319 | 292 | |
| | MD7021F | ł | 500 | 438 | |
| | MQ7021 | | 438 | 292 | |
| | | | Junction to Ambient | Junction to Case | |
| Coupling Factor | | | | | % |
| | MD7021 | | 83 | 40 | |
| | MD7021F | | 75 | 0 | |
| | MQ7021 | (Q1-Q2) | 57 | 0 | l |
| | | (Q1-Q3 or Q1-Q4) | 55 | 0 | 1 |

⁽¹⁾ ROJA is measured with the device soldered into a typical printed circuit board.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------|----------|----------|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, Ig = 0) | V(BR)CEO | 40 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 50 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (Ig = 10 µAdc, IC = 0) | V(BR)EBO | 5.0 | | _ | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, I _E = 0) | ІСВО | | <u> </u> | 100 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 100 μAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc) | hFE | 40 50 | 65 70 | _ | _ |

MD7021,F, MQ7021

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------------------|----------|-----|------|------|
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc)(2) | V _{CE(sat)} | - | _ | 0.35 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | V _{BE(sat)} | _ | _ | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 5.0 mAdc, VCE = 20 Vdc, f = 100 MHz) | fr | 200 | 320 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | C _{obo} | — | | 6.0 | pF |
| Input Capacitance (VBE = 2.0 Vdc, I _C = 0, f = 100 kHz) | Cibo | _ | - | 8.0 | pF |
| SWITCHING CHARACTERISTICS | | | | | |
| Turn-On Time (VCC = 30 Vdc, VBE(off) = 0.5 Vdc, IC = 150 mAdc, IB1 = 15 Adc) | ton | _ | 28 | - | ns |
| Turn-Off Time ($V_{CC} = 30 \text{ Vdc}$, $I_{C} = 150 \text{ mAdc}$, $I_{B1} = I_{B2} = 15 \text{ mAdc}$) | ^t off | _ | 72 | _ | ns |

⁽²⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

MD8001 MD8002 MD8003

CASE 654-07, STYLE 1

DUAL AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N2920 for graphs.

MAXIMUM RATINGS

| Rating | Symbol | V | Unit | | | | | |
|--|-----------------------------------|-------------|-------------------------|----------------|--|----|--|------|
| Collector-Emitter Voltage MD8001 MD8002 MD8003 | VCEO | | Vdc | | | | | |
| Collector Current — Continuous | ľc | 30 | | 30 | | 30 | | mAdc |
| | | One Die | Both Die Equal Power | | | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 575 3.29 | 625 3.57 | mW mW/°C | | | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.8 10.3 | 2.5 14.3 | Watts mW/°C | | | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 t | •€ | | | | | |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | One Die Max | Both Die Equal Power Max | Unit |
|--|----------------------|------------------------|--------------------------------|------|
| Thermal Resistance, Junction to Case | ReJC | 97 | 70 | •c/w |
| Thermal Resistance, Junction to Ambient | R _{ØJA} (1) | 304 | 280 | •C/W |
| | • | Junction to Ambient | Junction to Case | |
| Coupling Factor | | 84 | 44 | % |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|----------------------------|------------------|----------------|-----|-----|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, IB = 0) | MD8001 MD8002 MD8003 | V(BR)CEO | 40 50 60 | 111 | 111 | Vdc |
| Collector Cutoff Current (VCB = 40 Vdc, I _E = 0) | | ІСВО | _ | _ | 50 | nAdc |
| Emitter Cutoff Current (VEB = 4.0 Vdc, IC = 0) | | IEBO | | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain (IC = 1.0 mAdc, VCE = 10 Vdc) | | phE | 100 | 200 | _ | _ |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product(2) (IC = 5.0 mAdc, VCE = 10 Vdc, f = 100 MHz) | | fΤ | - | 260 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | | C _{obo} | | 2.6 | _ | pF |
| Input Capacitance (VBE = 2.0 Vdc, IC = 0, f = 100 kHz) | | C _{ibo} | _ | 2.3 | _ | pF |
| MATCHING CHARACTERISTICS | | | | | | |
| Base-Emitter Voltage Differential (IC = 1.0 mAdc, VCE = 10 Vdc) | | VBE1-VBE2 | _ | _ | 15 | mVdc |

⁽²⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MAXIMUM RATINGS

| WANIMON NATINGS | | | | | | |
|--|----------------------|--------------------|-----------------|----------------|--|-----|
| Rating | Symbol | Value | | Unit | | |
| Collector-Emitter Voltage | VCEO | 15 | | Vdc | | |
| Collector-Base Voltage | VCBO | 3 | 0 | Vdc | | |
| Emitter-Base Voltage | VEBO | 3.0 | | 3.0 | | Vdc |
| Collector Current — Continuous | jC | 50 | | mAdc | | |
| | | Each Transistor | Total Device | | | |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 0.65 3.72 | 1.9 10.88 | Watts mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.3 7.43 | 4.6 26.3 | Watts mW/°C | | |
| Operating and Storage Junction Temperature Range | Tj, T _{stg} | -65 to +200 | | °C | | |

MHQ918

CASE 632-02, STYLE 1 TO-116

QUAD AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MD918 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|----------------------|-----|-----------------|----------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 3.0 mAdc, IB = 0) | V(BR)CEO | 15 | | <u> </u> | Vdc |
| Collector-Base Breakdown Voltage (I _C = 1.0 µAdc, I _E = 0) | V(BR)CBO | 30 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | V(BR)EBO | 3.0 | | | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, I _E = 0) | Ісво | _ | _ | 10 | nAdc |
| ON CHARACTERISTICS(1) | | | <u> </u> | | |
| DC Current Gain (IC = 0.1 mAdc, V _{CE} = 1.0 Vdc) (IC = 3.0 mAdc, V _{CE} = 1.0 Vdc) (IC = 10 mAdc, V _{CE} = 1.0 Vdc) | hFE | 20 | 110 80 50 | = | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | VCE(sat) | _ | 0.11 | 0.4 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | V _{BE(sat)} | | 0.84 | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | <u> </u> | L | |
| Current-Gain — Bandwidth Product {IC = 4.0 mAdc, VCE = 10 Vdc, f = 100 MHz} | fτ | 600 | 850 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 140 kHz) | C _{obo} | _ | 0.75 | 2.0 | рF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 140 kHz) | C _{ibo} | | 1.4 | 2.5 | pF |
| Noise Figure (IC = 1.0 mAdc, V _{CE} = 6.0 Vdc, R _S = 400 Ohms, f = 60 MHz) | NF | | 4.0 | 6.0 | dB |

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MHQ2221 MHQ2222 **MPQ2221* MPQ2222***

MHQ2221 MHQ2222 **CASE 632-02, STYLE 1** TO-116

MPQ2221 MPQ2222 CASE 646, STYLE 1

QUAD **GENERAL PURPOSE TRANSISTOR**

NPN SILICON Refer to MD2218 for graphs.

| Rating | Symbol | Value | | Unit | | |
|--|-----------------------------------|------------------------------|-----------------|-------|--|-----|
| Collector-Emitter Voltage | VCEO | 4 | 0 | Vdc | | |
| Collector-Base Voltage | VCBO | 60 | | Vdc | | |
| Emitter-Base Voltage | VEBO | 5.0 | | 5.0 | | Vdc |
| Collector Current — Continuous | lc | 500 | | mAdc | | |
| | | Each Transistor | Total Device | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.65 | 1.9 | Watts | | |
| MHQ2221, MHQ2222 MPQ2221, MPQ2222 | | 3.72 5.2 | 10.88 15.2 | mW/°C | | |
| Operating and Storage Junction Temperature Range MHQ2221,22 MPQ2221,22 | T _J , T _{stg} | - 65 to +200 - 55 to +150 | | °C | | |

| ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.) | | | | | | |
|---|--------------------------------------|----------------------|-----------|----------|------------|-------------|
| Cheracteristic | | Symbol | Min | Тур | Max | Unit |
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage(1) (I _C = 10 mAdc, I _B = 0) | | V(BR)CEO | 40 | | | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | | V(BR)CBO | 60 | | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | | | Vdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) | | ICBO | | | 50 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | | IEBO | | | 50 | nAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain(1) (IC = 10 mAdc, VCE = 10 Vdc) | MHQ2221, MPQ2221 MHQ2222, MPQ2222 | hFE | 35 75 | = | _ | - |
| ($I_C = 150 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$) | MHQ2221, MPQ2221 MHQ2222, MPQ2222 | | 40 100 | <u>-</u> | = | |
| (IC = 300 mAdc, VCE = 10 Vdc) | MHQ2221, MPQ2221 MHQ2222, MPQ2222 | | 20 30 | - 1 | | |
| Collector-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) (IC = 300 mAdc, IB = 30 mAdc) | | VCE(sat) | | <u>-</u> | 0.4 1.6 | Vdc |
| Base-Emitter Saturation Voltage (IC = 150 mAdc, Ig = 15 mAdc) (IC = 300 mAdc, Ig = 30 mAdc) | | V _{BE(sat)} | <u>-</u> | | 1.3 2.6 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product(1) (IC = 20 mAdc, V _{CE} = 20 Vdc, f = 100 MHz) | | fT | 200 | 350 | | MHz . |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | | Cobo | | 4.5 | 8.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = 0, f = 100 kHz) | | C _{ibo} | | 17 | 30 | pF |
| SWITCHING CHARACTERISTICS | | | | | т | |
| Turn-On Time (VCC = 30 Vdc, VBE(off) = 0.5 Vdc, I _C = 150 mAdc, I _{B1} = 15 mAdc) | | ton | _ | 25 | _ | ns |
| Turn-Off Time (VCC = 30 Vdc, I _C = 150 mAdc, t _{B1} = t _{B2} = 15 mAdc) | | ^t off | | 250 | _ | ns |

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%. *MPQ2221A and MPQ2222A also available.

MHQ2221, MHQ2222, MPQ2221, MPQ2222

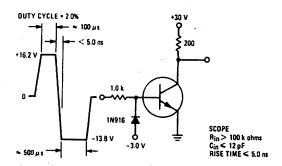
FIGURE 1 - DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT

GEMERATOR RISE TIME < 2.0 ns
PW < 200 ns
OUTY CYCLE = 2.0%

9.9 V

SCOPE
Rin > 100 k ohms
Cin < 12 pF
RISE TIME < 50 ns

FIGURE 2 – STORAGE TIME AND FALL TIME EQUIVALENT TEST CIRCUIT



MHQ2369 MPQ2369

MHQ2369 CASE 632-02, STYLE 1

MPQ2369 CASE 646-05, STYLE 1 TO-116

QUAD SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MIAAIMUM RATINGS | | | | |
|---|----------------------|--------------------|--------------------|----------------|
| Rating | Symbol | Va | lue | Unit |
| Collector-Emitter Voltage | VCEO | 1 | 5 | Vdc |
| Collector-Base Voltage | V _{CBO} | 4 | 0 | Vdc |
| Emitter-Base Voltage | VEBO | 4 | .5 | Vdc |
| Collector Current — Continuous | lc i | 50 | 00 | mAdc |
| | | Each Transistor | Total Device | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C MHQ2369 MPQ2369 | PD | 0.5 2.86 5.0 | 1.5 8.58 15 | Watts mW/°C |
| Operating and Storage Junction Temperature Range MHQ2369 MPQ2369 | TJ, T _{stg} | | o + 200 o + 125 | °C |

Refer to MD2369 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

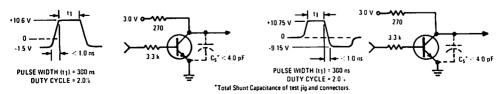
| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|----------------------|----------|-----|------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | V(BR)CEO | 15 | | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 40 | _ | | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | V(BR)EBO | 4.5 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 20 Vdc, IE = 0) | ІСВО | _ | | 0.4 | μAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | IEBO | - | _ | 0.5 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(1) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) (I _C = 100 mAdc, V _{CE} = 2.0 Vdc) | hFE | 40 20 | _ | | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | V _{CE(sat)} | 1 | | 0.25 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | V _{BE(sat)} | | _ | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 10 Vdc, f = 100 MHz) | fτ | 450 | 550 | _ | MHz |
| Output Capacitance (VCB = 5.0 Vdc, I _E = 0, f = 140 kHz) | C _{obo} | _ | 2.5 | 4.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 140 kHz) | C _{ibo} | _ | 3.0 | 5.0 | pF |
| SWITCHING CHARACTERISTICS | | | | | |
| Turn-On Time (V _{CC} = 3.0 Vdc, V _{BE} = 1.5 Vdc, I _C = 10 mAdc, I _{B1} = 3.0 mAdc) | ton | _ | 9.0 | _ | ns |
| Turn-Off Time (V _{CC} = 3.0 Vdc, I _C = 10 mAdc, I _{B1} = 3.0 mAdc, I _{B2} = 1.5 mAdc) | toff | _ | 15 | _ | ns |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle = 2.0%.

SWITCHING TIME EQUIVALENT TEST CIRCUITS

FIGURE 1 - ton CIRCUIT

FIGURE 2 - toff CIRCUIT



SMALL-SIGNAL DEVICES

| TEPARITORI TUATIITGS | | | | |
|--|-----------------------------------|--------------------|-----------------|----------------|
| Rating | Symbol | Value | | Unit |
| Collector-Emitter Voltage | VCEO | 40 |) | Vdc |
| Collector-Base Voltage | V _{CBO} | 60 | | Vdc |
| Emitter-Base Voltage | VEBO | 6. | 6.0 | |
| Collector Current — Continuous | lc | 50 |) | mAdc |
| | | Each Transistor | Total Device | |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 0.6 3.42 | 1.8 10.3 | Watts mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 6.85 | 4.2 24 | Watts mW/°C |
| Operating and Storage Junction | T _J , T _{stg} | -65 to | + 200 | °C |

MHQ2483 MHQ2484

CASE 632-02, STYLE 1 TO-116

QUAD AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N2919 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|--------------------|----------------------|------------|--------------|-------------|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 10 mAdc, IB = 0) | | V(BR)CEO | 40 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 μAdc, IE = 0) | | V _{(BR)CBO} | 60 | | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | - | V(BR)EBO | 6.0 | | _ | Vdc |
| Collector Cutoff Current (VCB = 45 Vdc, I _E = 0) | | ІСВО | _ | _ | 20 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | | IEBO | _ | _ | 20 | nAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain (I _C = 0.1 mAdc, V _{CE} = 5.0 Vdc) | MHQ2483 MHQ2484 | hFE | 100 200 | = | = | _ |
| $(I_C = 1.0 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$ | MHQ2483 MHQ2484 | | 150 300 | _ | _ _ | |
| (IC = 10 mAdc, VCE = 5.0 Vdc) | MHQ2483 MHQ2484 | | 150 300 | _ | _ | |
| Collector-Emitter Saturation Voltage (I _C = 1.0 mAdc, I _B = 0.1 mAdc) (I _C = 10 mAdc, I _B = 1.0 mAdc) | - | VCE(sat) | | 0.13 0.15 | 0.35 0.5 | Vdc |
| Base-Emitter On Voltage (I _C = 100 μAdc, V _{CE} = 5.0 Vdc) (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) | | V _{BE(on)} | _ | 0.58 0.70 | 0.7 0.8 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product (IC = 500 µAdc, VCE = 5.0 Vdc, f = 20 MHz) | | fτ | 50 | 100 | _ | MHz |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 100 kHz) | | C _{ibo} | _ | 4.0 | 8.0 | pF |
| Collector-Base Capacitance (VCB = 5.0 Vdc, IE = 0, f = 100 kHz) | | C _{cb} | _ | 1.8 | 6.0 | pF |
| Noise Figure (I _C = 10 μ Adc, V _{CE} = 5.0 Vdc, R _S = 10 kohms, f = 10 Hz to 15.7 kHz, BW = 10 kHz) | MHQ2483 MHQ2484 | NF | | 3.0 2.0 | _ | dB |

MHQ2906 MHQ2907 MPQ2906* MPQ2907*

MHQ2906, MHQ2907 **CASE 632-02, STYLE 1**

MPQ2906 MPQ2907 **CASE 646-05, STYLE 1** TO-116

QUAD **GENERAL PURPOSE TRANSISTOR**

PNP SILICON

Refer to MD2904 for graphs.

| MAXIMUM RATINGS | | | | | | | | |
|--|-----------------------------------|--------------------|-----------------|-------|--|-----|--|------|
| Rating | Symbol | Value | | Unit | | | | |
| Collector-Emitter Voltage | VCEO | 4 | 0 | Vdc | | | | |
| Collector-Base Voltage | V _{CBO} | 6 | 0 | Vdc | | | | |
| Emitter-Base Voltage | VEBO | 5.0 | | 5.0 | | Vdc | | |
| Collector Current — Continuous | lc | 600 | | 600 | | 600 | | mAdc |
| | | Each Transistor | Total Device | | | | | |
| Total Device Dissipation @ T _A = 25°C | PD | 0.65 | 1.9 | Watts | | | | |
| Derate above 25°C MHQ2906, MHQ2907 MPQ29006. | | 3.72 | 10.88 | mW/°C | | | | |
| MPQ2907 | | 6.5 | 19 | | | | | |
| Operating and Storage Junction Temperature Range MHQ2906,07 MPQ2906,07 | T _J , T _{stg} | | + 200 + 125 | °C | | | | |

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|--------------------------------------|----------------------|-----------|-----|------------|---------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1 | 0 mAdc, IB = 0) | V(BR)CEO | 40 | - | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 μA | dc, (g = 0) | V(BR)CBO | 60 | - | _ | Vdc |
| mitter-Base Breakdown Voltage (IE = 10 µAdd | c, IC = 0) | V(BR)EBO | 5.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0 |) | ІСВО | _ | _ | 50 | nAdc |
| mitter Cutoff Current (VCB = 3.0 Vdc, IE = 0) | | IEBO | _ | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | | | - |
| OC Current Gain(1) (IC = 10 mAdc, V _{CE} = 10 Vdc) | MHQ2906, MPQ2906 MHQ2907, MPQ2907 | hFE | 35 75 | = | = | _ |
| (IC = 150 mAdc, V _{CE} = 10 Vdc) | MHQ2906, MPQ2906 MHQ2907, MPQ2907 | | 40 100 | _ | _ | } |
| (IC = 300 mAdc, VCE = 10 Vdc) | MHQ2906, MPQ2906 MHQ2907, MPQ2907 | | 30 50 | | | <u></u> |
| Collector-Emitter Saturation Voltage(1) (IC = 150 mAdc, IB = 15 mAdc) (IC = 300 mAdc, IB = 30 mAdc) | | VCE(sat) | - | _ | 0.4 1.6 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 150 mAdc, IB = 15 mAdc) (IC = 300 mAdc, IB = 30 mAdc) | | V _{BE(sat)} | - | _ | 1.3 2.6 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current:Gain — Bandwidth Product (IC = 50 mAdc, VCE = 20 Vdc, f = 100 MHz) | | fT | 200 | 350 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | | C _{obo} | - | 6.0 | 8.0 | pF |
| Input Capacitance (VBE = 2.0 Vdc, I _C = 0, f = 100 kHz) | | C _{ibo} | _ | 20 | 30 | pF |
| SWITCHING CHARACTERISTICS | | | | | | |
| Turn-On Time (VCC = 30 Vdc, IC = 150 mAdc, IB1 = 15 mA | Adc) | ton | _ | 30 | | ns |
| Turn-Off Time (VCC = 6.0 Vdc, IC = 150 mAdc, IB1 = IB2 = | | toff | _ | 100 | - | ns |

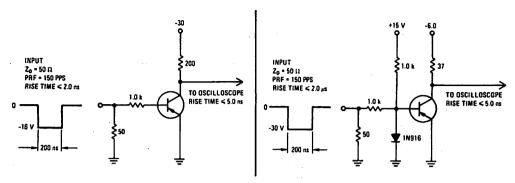
⁽¹⁾ Pulse Test: Pulse Width < 300 μs, Duty Cycle = 2.0%.

^{*}MPQ2906A and MPQ2907A also available.

MHQ2906, MHQ2907, MPQ2906, MPQ2907

FIGURE 1 - DELAY AND RISE TIME TEST CIRCUIT

FIGURE 2 – STORAGE AND FALL TIME TEST CIRCUIT



MHQ3467

CASE 632-02, STYLE 1 TO-116

QUAD MEMORY DRIVER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| MAXIMON NATINGS | | | | | | |
|--|-----------------------------------|--------------------|-----------------|----------------|--|-----|
| Rating | Symbol | Val | Unit | | | |
| Collector-Emitter Voltage | VCEO | 4 | 0 | Vdc | | |
| Collector-Base Voltage | VCBO | 40 | | 40 | | Vdc |
| Emitter-Base Voltage | VEBO | 5. | 0 | Vdc | | |
| Collector Current — Continuous | lc | 1.0 | | Adc | | |
| | | Each Transistor | Total Device | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.9 5.14 | 2.7 15.4 | Watts mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.8 10.3 | 6.3 36 | Watts mW/°C | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 55 to | + 200 | °C | | |

Refer to MD3467 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|------------------|-----|------|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, Ig = 0) | V(BR)CEO | 40 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 40 | _ | ı | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | V(BR)EBO | 5.0 | _ | 1 | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, I _E = 0) | ІСВО | - | _ | 200 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | IEBO | - | _ | 200 | nAdc |
| ON CHARACTERISTICS | · | | | | |
| DC Current Gain(1) (I _C = 500 mAdc, V _{CE} = 1.0 Vdc) | hFE | 20 | _ | _ | |
| Collector-Emitter Saturation Voltage(1) (IC = 500 mAdc, Ig = 50 mAdc) | VCE(sat) | _ | 0.23 | 0.5 | Vdc |
| Base-Emitter Saturation Voltage(1) (IC = 500 mAdc, IB = 50 mAdc) | VBE(sat) | _ | 0.9 | 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product(1) (IC = 50 mAdc, VCE = 10 Vdc, f = 100 MHz) | fT | 125 | 190 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | _ | 10 | 25 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 100 kHz) | C _{ibo} | _ | 55 | 80 | pF |
| SWITCHING CHARACTERISTICS | | | | | |
| Turn-On Time (!C = 500 mAdc, IB1 = 50 mAdc) | ^t on | _ | _ | 40 | ns |
| Turn-Off Time (IC = 500 mAdc, IB1 = IB2 = 50 mAdc) | ^t off | _ | | 90 | ns |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| MAXIMUM KATINGS | | | | | |
|--|--------------------|----------------------|--------------------|-------------------|----------------|
| Rating | | Symbol | Value | | Unit |
| Collector-Emitter Voltage | | VCEO | 1 | 2 | Vdc |
| Collector-Base Voltage | | VCBO | 1 | 5 | Vdc |
| Emitter-Base Voltage | | VEBO | 4. | 5 | Vdc |
| Collector Current — Contin | nuous | ĵĊ | 200 | | mAdc |
| | | | Each Transistor | Total Device | |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | MHQ3546 MPQ3546 | PD | 0.5 2.86 4.0 | 1.5 8.58 12 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | MHQ3546 MPQ3546 | TJ, T _{stg} | | + 200 + 150 | °C |

MHQ3546 MPQ3546

MHQ3546 CASE 632-02, STYLE 1 TO-116

MPQ3546 CASE 646-05, STYLE 1

QUAD SWITCHING TRANSISTOR

PNP SILICON

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|----------------------|----------|------------|----------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | V(BR)CEO | 12 | | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 15 | | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | V(BR)EBO | 4.5 | _ | <u> </u> | Vdc |
| Collector Cutoff Current (VCB = 10 Vdc, IE = 0) | ІСВО | _ | | 0.1 | μAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | IEBO | _ | 1 – | 0.1 | μAdc |
| ON CHARACTERISTICS | | | | • | |
| DC Current Gain(1) (IC = 10 mAdc, V _{CE} = 1.0 Vdc) (IC = 100 mAdc, V _{CE} = 1.0 Vdc) | hFE | 30 15 | = | _ | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | V _{CE(sat)} | _ | _ | 0.25 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, I _B = 1.0 mAdc) | V _{BE(sat)} | _ | - | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | <u>-</u> | | | · |
| Current-Gain — Bandwidth Product(1) (IC = 10 mAdc, VCE = 10 Vdc, f = 100 MHz) | fT | 600 | 1000 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | _ | 2.0 | 6.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | C _{ibo} | _ | 3.5 | 8.0 | pF |
| SWITCHING CHARACTERISTICS | | | | | |
| Turn-On Time (V _{CC} = 2.0 Vdc, V _{BE(off)} = 3.0 Vdc, I _C = 30 mAdc, I _{B1} = 1.5 mAdc) | ton | _ | 15 | _ | ns |
| Turn-Off Time (VCC = 2.0 Vdc, I _C = 30 mAdc, I _{B1} = I _{B2} = 1.5 mAdc) (1) Pulse Test: Pulse Width < 300 vs. Puth Cycle < 3.09 | toff | _ | 25 | _ | ns |

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MHQ3798 MHQ3799

CASE 632-02, STYLE 1 TO-116

QUAD AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| MANIMON IDATINGO | | | | | | |
|--|----------------------|--------------------|-----------------|----------------|--|-----|
| Rating | Symbol | MHQ3798 | MHQ3799 | Unit | | |
| Collector-Emitter Voltage | VCEO | 40 | 60 | Vdc | | |
| Collector-Base Voltage | V _{CBO} | 60 | | 60 | | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc | | |
| Collector Current — Continuous | ភ | 50 | | mAdc | | |
| | | Each Transistor | Total Device | | | |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 0.5 2.86 | 1.5 8.58 | Watts mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 5.71 | 3.5 20 | Watts mW/°C | | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to | °C | | | |

Refer to 2N3810 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|--------------------|----------------------|------------|------------|-------------|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage(1) (I _C = 10 mAdc, I _B = 0) | MHQ3798 MHQ3799 | V(BR)CEO | 40 60 | 1-1 | 11 | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = | : 0) | V(BR)CBO | 60 | 1 | - | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 μ Adc, IC = 0 | D) | V(BR)EBO | 5.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) | | Ісво | | | 10 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | | IEBO | | | 20 | nAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain(1) (I _C = 10 µAdc, V _{CE} = 5.0 Vdc) | MHQ3798 MHQ3799 | hFE | 100 225 | <u> </u> | _ | |
| $(I_C = 100 \ \mu Adc, V_{CE} = 5.0 \ Vdc)$ | MHQ3798 MHQ3799 | | 150 300 | = | _ | |
| $(I_C = 500 \ \mu Adc, V_{CE} = 5.0 \ Vdc)$ | MHQ3798 MHQ3799 | | 150 300 | = | _ | |
| (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) | MHQ3798 MHQ3799 | | 125 250 | = | =_ | |
| Collector-Emitter Saturation Voltage (I _C = 100 μ Adc, I _B = 10 μ Adc) (I _C = 1.0 mAdc, I _B = 100 μ Adc) | | VCE(sat) | 1 1 | = | 0.2 0.25 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 100 μAdc, I _B = 10 μAdc) (I _C = 1.0 mAdc, I _B = 100 μAdc) | | V _{BE(sat)} | 1-1 | = | 0.7 0.8 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 100 MHz) | | fT | | 130 | - | MHz |
| Output Capacitance (VCB = 5.0 Vdc, I _E = 0, f = 100 kHz) | | C _{obo} | _ | 2.3 | - | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 100 kHz) | | C _{ibo} | _ | 5.5 | _ | pF |
| Noise Figure (I _C = 100 μ Adc, V _{CE} = 10 Vdc, R _S = 3.0 kohms, f = 10 Hz to 15.7 kHz) | MHQ3798 MHQ3799 | NF | = | 2.5 1.5 | | dB |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| MACKINION PATTINGS | | | | |
|--|-----------------------------------|--------------------|------------------------------------|----------------|
| Rating | Symbol | MHQ4001A | MHQ4002A | Unit |
| Collector-Emitter Voltage | VCEO | - 40 | 45 | Vdc |
| Collector-Emitter Voltage | VCES | 60 | 70 | Vdc |
| Collector-Base Voltage | VCBO | 60 | 70 | Vdc |
| Emitter-Base Voltage | VEBO | 6 | .0 | Vdc |
| Collector Current — Continuous | ľc | 1.5 | | Adc |
| | | Each Transistor | Four Transistors Equal Power | |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 750 4.3 | 2500 14.3 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 6.86 | 4.0 22.8 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to | °C | |

MHQ4001A MHQ4002A

CASE 632-02, STYLE 1 TO-116

QUAD MEMORY DRIVER TRANSISTOR

NPN SILICON

Refer to MD3725 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|---|----------------|----------------------|----------------------|------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) MHQ4001 MHQ4002 | - | 40 45 | _ | | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 10 \(\mu\)Adc, VBE = 0) MHQ4001\(\mu\)MHQ4002\(\mu\)MHQ4002\(\mu\) | a contract of the contract of | 60 70 | _ | = | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) MHQ4001, MHQ4002, | · . | 60 70 | | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μ Adc, I _C = 0) | V(BR)EBO | 6.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0) | ІСВО | - | _ | 500 | nAdc |
| ON CHARACTERISTICS(1) | | | | · | L . |
| DC Current Gain (I _C = 100 mAdc, V _{CE} = 1.0 Vdc) (I _C = 500 mAdc, V _{CE} = 1.0 Vdc) (I _C = 1.0 Adc, V _{CE} = 5.0 Vdc) | hFE | 50 30 20 | 100 60 45 | 250 — | _ |
| Collector-Emitter Saturation Voltage (IC = 100 mAdc, IB = 10 mAdc, IC = 500 mAdc, IB = 500 mAdc, IC = 1.0 Adc, IB = 100 mAdc) | | | 0.14 0.23 0.36 | 0.26 0.52 0.95 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 100 mAdc, I _B = 10 mAdc) (I _C = 500 mAdc, I _B = 50 mAdc) (I _C = 1.0 Adc, I _B = 100 mAdc) | V _{BE(sat)} | 0.8 — | 0.75 0.88 1.0 | 0.86 1.1 1.7 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product(1) (IC = 50 mAdc, VCE = 10 Vdc, f = 100 MHz) | fτ | 200 | 275 | _ | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | _ | 5.0 | 10 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 100 kHz) | C _{ibo} | - | 55 | 70 | pF |
| SWITCHING CHARACTERISTICS | | | | - | |
| Turn-On Time ($V_{CC} = 30 \text{ Vdc}$, $I_{C} = 0.5 \text{ Adc}$, $V_{BE} = 3.8 \text{ Vdc}$, $I_{B1} = 50 \text{ mAdc}$) | ton | _ | 30 | 40 | ns |
| Turn-Off Time ($V_{CC} = 30 \text{ Vdc}$, $I_{C} = 0.5 \text{ Adc}$, $I_{B1} = I_{B2} = 50 \text{ mAdc}$) | ^t off | _ | 60 | 75 | ns |

MHQ4013 MHQ4014

CASE 632-02, STYLE 1 TO-116

QUAD MEMORY DRIVER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MAXIMUM KATINGS | | | | | | |
|--|-----------------------------------|--------------------|---------------------------------------|----------------|--|-----|
| Rating | Symbol | MHQ4013 | MHQ4014 | Unit | | |
| Collector-Emitter Voltage | VCEO | 40 | 45 | Vdc | | |
| Collector-Emitter Voltage | VCES | 60 | 70 | Vdc | | |
| Collector-Base Voltage | VCBO | 60 | 70 | Vdc | | |
| Emitter-Base Voltage | VEBO | 6 | .0 | Vdc | | |
| Collector Current — Continuous | lc | 1.5 | | 1.5 | | Adc |
| | | Each Transistor | Four Transistors Equal Power | | | |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 750 4.3 | 2500 14.3 | mW mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 6.86 | 4.0 22.8 | Watts mW/°C | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | – 55 to | + 200 | င္ | | |

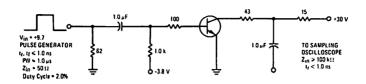
Refer to MD3725 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------------------|----------------|----------------------|----------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, Ig = 0) MHQ4013 MHQ4014 | V(BR)CEO | 40 45 | = | _ | Vdc |
| Collector-Emitter Breakdown Voltage (I _C = 10 μ Adc, V _{BE} = 0) MHQ4013 MHQ4014 | V(BR)CES | 60 70 | = | = | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 µAdc, I _E = 0) MHQ4013 MHQ4014 | V(BR)CBO | 60 70 | _ | 1-1 | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 6.0 | | _ | Vdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) | СВО | _ | _ | 500 | nAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain (I _C = 100 mAdc, V _{CE} = 1.0 Vdc) (I _C = 500 mAdc, V _{CE} = 1.0 Vdc) (I _C = 1.0 Adc, V _{CE} = 5.0 Vdc) | hFE | 60 35 25 | 100 65 50 | 250 — — | _ |
| Collector-Emitter Saturation Voltage (I _C = 100 mAdc, I _B = 10 mAdc) (I _C = 500 mAdc, I _B = 50 mAdc) (I _C = 1.0 Adc, I _B = 100 mAdc) | VCE(sat) | | 0.14 0.23 0.36 | 0.26 0.52 0.95 | Vdc |
| Base-Emitter Saturation Voltage (IC = 100 mAdc, IB = 10 mAdc) (IC = 500 mAdc, IB = 50 mAdc) (IC = 1.0 Adc, IB = 100 mAdc) | V _{BE(sat)} | 0.8 — | 0.75 0.88 1.0 | 0.86 1.1 1.7 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | _ | |
| Current-Gain — Bandwidth Product(1) (IC = 50 mAdc, VCE = 10 Vdc, f = 100 MHz) | fT | 200 | 275 | _ | MHz |
| Output Capacitence (VCB = 10 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | _ | 5.0 | 10 | pF |
| (VBE = 0.5 Vdc, IC = 0, f = 100 kHz) | C _{ibo} | _ | 50 | 70 | pF |
| SWITCHING CHARACTERISTICS | | | | | |
| Turn-On Time (V _{CC} = 30 Vdc, I _C = 0.5 Adc, V _{BE(off)} = 3.8 Vdc, I _{B1} = 50 mAdc) | ton | - | 20 | 35 | ns |
| Turn-Off Time $(V_{CC} = 30 \text{ Vdc}, I_C = 0.5 \text{ Adc}, I_{B1} = I_{B2} = 50 \text{ mAdc})$ | ^t off | _ | 50 | 60 | ns |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

FIGURE 1 - TURN-ON AND TURN-OFF SWITCHING TIMES TEST CIRCUIT



MHQ6001 MHQ6002

CASE 632-02, TYPE 1 TO-116

QUAD COMPLEMENTARY TRANSISTOR

NPN/PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Va | Unit | |
|--|-----------------------------------|--------------------|-----------------|----------------|
| Collector-Emitter Voltage | VCEO | 3 | 30 | Vdc |
| Collector-Base Voltage | V _{CBO} | 6 | ю | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc |
| Collector Current — Continuous | !c | 50 | 00 | mAdc |
| | | Each Transistor | Total Device | |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 0.65 3.72 | 1.9 10.88 | Watts mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.3 7.43 | 4.6 26.3 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 65 to | °C | |

Refer to MHQ2222 for NPN graphs.*

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|--------------------|----------------------|-----------|------------|-------------|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, I | B = 0) | V(BR)CEO | 30 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0 |)) | V(BR)CBO | 60 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 μ Adc, IC = 0) | | V(BR)EBO | 5.0 | | _ | Vdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) | | СВО | _ | _ | 20 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | | ^I EBO | _ | _ | 30 | nAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain(1) (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) | MHQ6001 MHQ6002 | hFE | 25 50 | _ | - | - |
| (I _C = 10 mAdc, V _{CE} = 10 Vdc) | MHQ6001 MHQ6002 | | 35 75 | = | _ _ _ | |
| (I _C = 150 mAdc, V _{CE} = 10 Vdc) | MHQ6001 MHQ6002 | | 40 100 | = | _ | |
| (IC = 300 mAdc, VCE = 10 Vdc) | MHQ6001 MHQ6002 | | 20 30 | = | | |
| Collector-Emitter Saturation Voltage(1) (IC = 150 mAdc, (IC = 300 mAdc, | | VCE(sat) | | = | 0.4 1.4 | Vdc |
| Base-Emitter Saturation Voltage(1) (I _C = 150 mAdc, I _B = (I _C = 300 mAdc, I _B = | | V _{BE(sat)} | <u>-</u> | <u> </u> | 1.3 2.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product(1) (IC = 50 mAdc, V(f = 100 kHz) | CE = 20 Vdc, | ÍΤ | _ | 400 | | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | NPN PNP | C _{obo} | _ | 6.0 4.5 | = | pF |
| Input Capacitance (VBE = 2.0 Vdc, I _C = 0, f = 100 kHz) | NPN PNP | C _{ibo} | _ | 20 17 | _ | pF |
| SWITCHING CHARACTERISTICS | | | | | | |
| Turn-On Time $(V_{CC} = 30 \text{ Vdc}, V_{BE} = 0.5 \text{ Vdc}, I_{C} = 150 \text{ mAdc}, I_{B1} = 15 \text{ mAdc})$ | | ton | _ | 30 | _ | ns |
| Turn-Off Time (V _{CC} = 30 Vdc, I _C = 150 mAdc, I _{B1} = I _{B2} = 15 mAdc) | | ^t off | _ | 225 — | _ | ns |
| 1) Bules Tests Bules Width = 200 us Duty Cycle = 2 0% | · | | | | | |

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%. *Refer to MHQ2907 for PNP graphs.

| WANTED TEATHER | | | | |
|---|----------|--------------------|-----------------|----------------|
| Rating | Symbol | MHQ6100 | MHQ6100A | Unit |
| Collector-Emitter Voltage | VCEO | 40 | 45 | Vdc |
| Collector-Base Voltage | VCBO | 60 | | Vdc |
| Emitter-Base Voltage | VEBO | 5 | i.0 | Vdc |
| Collector Current — Continuous | lc | | 50 | mAdc |
| | | Each Transistor | Total Device | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.5 2.86 | 1.5 8.58 | Watts mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 5.71 | 3.5 20 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | Tj, Tstg | -65 to +200 | | ℃ |

MHQ6100,A

CASE 632-02, TYPE 2 TO-116

QUAD COMPLEMENTARY PAIR TRANSISTOR

NPN/PNP SILICON

Refer to MHQ2483 for NPN graphs. Refer to MHQ3798 for PNP graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|---------------------|----------------------|-----------|------------|------|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | MHQ6100 MHQ6100A | V(BR)CEO | 40 45 | - | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | | V(BR)CBO | 60 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 μAdc, IC = 0) | | V _{(BR)EBO} | 5.0 | _ | - | Vdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) | | СВО | _ | _ | 10 | nAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain(1) (IC = 100 μ Adc, VCE = 5.0 Vdc) | MHQ6100 MHQ6100A | hFE | 50 100 | _ | - 1 | _ |
| (I _C = 500 μAdc, V _{CE} = 5.0 Vdc) | MHQ6100 MHQ6100A | | 75 150 | | - | |
| $(I_C = 1.0 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$ | MHQ6100 MHQ6100A | | 75 150 | = | _ | |
| (IC = 10 mAdc, V_{CE} = 5.0 Vdc) | MHQ6100 MHQ6100A | | 60 125 | = | = | |
| Collector-Emitter Saturation Voltage (IC = 1.0 mAdc, Ig = 0.1 mAdc) | | VCE(sat) | - | - | 0.25 | Vdc |
| Base-Emitter Saturation Voltage (IC = 1.0 mAdc, IB = 0.1 mAdc) | | V _{BE(sat)} | _ | _ | 0.8 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product (I _C = 500 µAdc, V _{CE} = 5.0 Vdc, f = 20 MHz) | NPN PNP | fΤ | _ | 175 130 | | MHz |
| Output Capacitance (VCB = 5.0 Vdc, I _E = 0, f = 100 kHz) | NPN PNP | Cobo | = | 4.5 2.3 | _ | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 100 kHz) | NPN PNP | C _{ibo} | _ | 6.0 5.5 | - | pF |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MPQ918

CASE 646-05, STYLE 1 TO-116

QUAD AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MD918 for graphs.

MAXIMUM RATINGS

| MAXIMUM KATINGS | | | | | | |
|--|-----------------------------------|--------------------|------------------------------------|----------------|--|------|
| Rating | Symbol | Va | Unit | | | |
| Collector-Emitter Voltage | VCEO | 1 | 5 | Vdc | | |
| Collector-Base Voltage | VCBO | 3 | 10 | Vdc | | |
| Emitter-Base Voltage | VEBO | 3.0 | | Vdc | | |
| Collector Current — Continuous | -C | 50 | | 50 | | mAdc |
| | | Each Transistor | Four Transistors Equal Power | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 500 4.0 | 900 7.2 | mW mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 6.7 0.825 | 2.4 19.2 | Watts mW/°C | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | – 55 to | °C | | | |

THERMAL CHARACTERISTICS

| Charac | teristic | Junction to Case | Junction to Ambient | Unit |
|--------------------|------------------|---------------------|------------------------|------|
| Thermal Resistance | Each Die | 151 | 250 | .cw |
| | Effective, 4 Die | 52 | 134 | .cw |
| Coupling Factors | Q1-Q4 or Q2-Q3 | 34 | 70 | % |
| | Q1-Q2 or Q3-Q4 | 2.0 | 26 | % |

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------------------|------------|-----------------|-----|------|
| OFF CHARACTERISTICS | _ | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 3.0 mAdc, IB = 0) | V(BR)CEO | 15 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 1.0 μAdc, I _E = 0) | V(BR)CBO | 30 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 3.0 | _ | | Vdc |
| Collector Cutoff Current (V _{CB} = 15 Vdc, I _E = 0) | ICBO | _ | - | 10 | nAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain ($I_C = 0.1$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 3.0$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc) | hFE | 20 | 110 80 50 | | - |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | V _{CE(sat)} | | 0.11 | 0.4 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | V _{BE(sat)} | _ | 0.84 | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (I _C = 4.0 mAdc, V _{CE} = 10 Vdc, f = 100 MHz) | fτ | 600 | 850 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 140 kHz) | Cobo | _ | 0.75 | 1.7 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = 0, f = 140 kHz) | C _{ibo} | _ | 1.1 | 2.0 | ρF |
| Noise Figure (Ic = 1.0 mAdc, Vcc = 6.0 Vdc, Rg = 400 Ohms, f = 60 MHz) | NF | _ | 4.0 | 6.0 | dB |

(1) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

| Rating | Symbol | Va | Unit | |
|--|----------------------|--------------------|------------------------------------|----------------|
| Collector-Emitter Voltage | VCEO | | Vdc | |
| Collector-Base Voltage | VCBO | | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 4 | 1.0 | Vdc |
| Collector Current — Continuous | lc | 5 | mAdc | |
| | | Each Transistor | Four Transistors Equal Power | |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 650 5.18 | 1250 10 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 8.0 | 3.0 24 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{Stg} | - 55 t | ో | |

THERMAL CHARACTERISTICS

| Char | acteristic | Junction to Case | Junction to Ambient | Unit |
|--------------------------------|----------------|---------------------|------------------------|------|
| Thermal Resistance(1) Each Die | | 125 | 193 | °C/W |
| Effective, 4 Die | | 41.6 | 100 | |
| Coupling Factors | Q1-Q4 or Q2-Q3 | 30 | 60 | % |
| | Q1-Q2 or Q3-Q4 | 2.0 | 24 | % |

MPQ1000

CASE 646-05, STYLE 1 TO-116

QUAD AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MD2218 for graphs.

(1) R_{BJA} is measured with the device soldered into a typical printed circuit board.

| ELECTRICA | L CHARACTERISTICS | (TA = | = 25°C unless otherwise noted.) |
|-----------|-------------------|-------|---------------------------------|
|-----------|-------------------|-------|---------------------------------|

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|----------------------|----------------|-----|-----|------|
| OFF CHARACTERISTICS | | | | | - |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, IB = 0) | V(BR)CEO | 20 | _ | | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 µAdc, I _E = 0) | V(BR)CBO | 40 | _ | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | V(BR)EBO | 4.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, I _E = 0) | ІСВО | | _ | 50 | nAdc |
| Emitter Cutoff Current (VEB = 2.0 Vdc, I _C = 0) | IEBO | | | 50 | nAdc |
| ON CHARACTERISTICS(2) | | | | | · |
| DC Current Gain (I _C = 10 mAdc, V _{CE} = 10 Vdc) (I _C = 50 mAdc, V _{CE} = 10 Vdc) (I _C = 150 mAdc, V _{CE} = 10 Vdc) | pŁE | 50 50 40 | = | = | _ |
| Collector-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc) | VCE(sat) | _ | _ | 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) | V _{BE(sat)} | _ | - | 1.3 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | • | |
| Current-Gain — Bandwidth Product (IC = 20 mAdc, VCE = 20 Vdc, f = 100 MHz) | fτ | 175 | _ | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | C _{obo} | _ | _ | 8.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 100 kHz) | C _{ibo} | | - | 30 | pF |

(2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MPQ1500

CASE 646-05, STYLE 1 TO-116 QUAD

PNP SILICON

Refer to MPQ2907 for graphs.

MAXIMUM RATINGS

| Rating | Symbol | Va | lue | Unit | | |
|--|-----------------------------------|--------------------|------------------------------------|----------------|--|------|
| Collector-Emitter Voltage | VCEO | 20 | | Vdc | | |
| Collector-Base Voltage | V _{CBO} | 4 | 10 | Vdc | | |
| Emitter-Base Voltage | VEBO | 4.0 | | Vdc | | |
| Collector Current — Continuous | lc | 500 | | 500 | | mAdc |
| | | Each Transistor | Four Transistors Equal Power | | | |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 0.65 5.18 | 1.25 8.0 | Watts mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | ₽D | 1.0 8.0 | 3.0 24 | Watts mW/°C | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 55 to + 150 | | °C | | |

THERMAL CHARACTERISTICS

| Characteristic | Junction to Case | Junction to Ambient | Unit |
|-----------------------|---------------------|------------------------|------|
| Thermal Resistance(1) | | | °C/W |
| Each Die | 125 | 193 | |
| Effective, 4 Die | 41.6 | 100 | |
| Coupling Factor | | | % |
| Q1-Q4 or Q2-Q3 | 30 | 60 | |
| Q1-Q2 or Q3-Q4 | 2.0 | 24 | |

(1) Junction to ambient data applies for typical printed circuit board mounting.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|----------------------|----------------|------------------|---------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 10 mAdc, IB = 0) | V(BR)CEO | 20 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 40 | _ | - | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | V(BR)EBO | 4.0 | _ | - | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, I _E = 0) | Ісво | 1 | _ | 50 | nAdc |
| Emitter Cutoff Current (VEB = 2.0 Vdc, IC = 0) | IEBO | - | _ | 50 | nAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gain (I _C = 10 mAdc, V _{CE} = 10 Vdc) (I _C = 50 mAdc, V _{CE} = 10 Vdc) (I _C = 150 mAdc, V _{CE} = 10 Vdc) | hFE | 50 50 40 | 100 120 80 | <u>-</u> - | _ |
| Collector-Emitter Saturation Voltage (I _C = 150 mAdc, I _B = 15 mAdc) | VCE(sat) | _ | 0.22 | 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 150 mAdc, IB = 15 mAdc) | V _{BE(sat)} | _ | 0.89 | 1.3 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product(1) (IC = 20 mAdc, VCE = 20 Vdc, f = 100 MHz) | fτ | 150 | 300 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | C _{obo} | _ | 4.5 | 8.0 | pF |
| Input Capacitance (VRF = 0.5 Vdc, IC = 0, f = 100 kHz) | C _{ibo} | - | 17 | 30 | pF |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MPQ2221, MPQ2222 For Specifications, See MHQ2221 Data.

MPQ2369 For Specifications, See MHQ2369 Data.

| Rating | Symbol | Va | lue | Unit |
|---|-----------------------------------|--------------------|------------------------------------|----------------|
| Collector-Emitter Voltage | VCEO | 4 | 40 | |
| Collector-Base Voltage | V _{CBO} | | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 6 | i.0 | Vdc |
| Collector Current — Continuous | lc | 50 | | mAdc |
| | | Each Transistor | Four Transistors Equal Power | |
| Total Device Dissipation @ T _A = 25°C(1) Derate above 25°C | PD | 500 4.0 | 900 7.2 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 0.825 6.7 | 2.4 19.2 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 55 to | °C | |

⁽¹⁾ Second Breakdown occurs at power levels greater than 3 times the power dissipation rating.

THERMAL CHARACTERISTICS

| Charac | teristic | Junction to Case | Junction to Ambient | Unit |
|--------------------|----------------------------------|---------------------|------------------------|--------|
| Thermal Resistance | Each Die Effective, 4 Die | 151 52 | 250 134 | °C/W |
| Coupling Factors | Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4 | 34 2.0 | 70 26 | % % |

MPQ2483 MPQ2484

CASE 646-05, STYLE 1 TO-116

QUAD AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N2919 for graphs.

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|--------------------|----------------------|------------|--------------|-------------|------|
| OFF CHARACTERISTICS | | | | • | | - |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, IB = 0) | | V(BR)CEO | 40 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 | | V(BR)CBO | 60 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | | V(BR)EBO | 6.0 | - | _ | Vdc |
| Collector Cutoff Current (VCB = 45 Vdc, lg = 0) | | Ісво | - | _ | 20 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, I _C = 0) | | IEBO | - | - | 20 | nAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain(2) (I _C = 0.1 mAdc, V _{CE} = 5.0 Vdc) | MPQ2483 MPQ2484 | hFE | 100 200 | = | = | _ |
| $(I_C = 1.0 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$ | MPQ2483 MPQ2484 | | 150 300 | = | _ | |
| (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) | MPQ2483 MPQ2484 | | 150 300 | = | _ | |
| Collector-Emitter Saturation Voltage (IC = 1.0 mAdc, IB = 0.1 mAdc) (IC = 10 mAdc, IB = 1.0 mAdc) | | VCE(sat) | | 0.13 0.15 | 0.35 0.5 | Vdc |
| Base-Emitter Saturation Voltage(2) (IC = 100 µAdc, VCE = 5.0 Vdc) (IC = 10 mAdc, VCE = 5.0 Vdc) | _ | V _{BE(sat)} | = | 0.58 0.70 | 0.7 0.8 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | • |
| Current-Gain — Bandwidth Product (IC = 500 µAdc, VCE = 5.0 Vdc, f = 20 MHz) | | fT | 50 | 100 | _ | MHz |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 100 kHz) | | Cibo | _ | 4.0 | 8.0 | pF |

MPQ2483, MPQ2484

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|---------|-----------------|-----|-----|-----|------|
| Collector-Base Capacitance (VCB = 5.0 Vdc, IE = 0, f = 100 kHz) | | C _{cb} | 1 | 1.8 | 6.0 | pF |
| Noise Figure | | NF | 1 | | | dB |
| (IC = 10 μ Adc, VCE = 5.0 Vdc, Rs = 10 kohms, | MPQ2483 | | l — | 3.0 | - | |
| f = 10 Hz to 15.7 kHz, BW = 10 kHz) | MPQ2484 | | | 2.0 | - | |

⁽²⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| WAXIIVUW KATUNGS | | | | |
|--|----------------------|--------------------|------------------------------------|----------------|
| Rating | Symbol | Va | Unit | |
| Collector-Emitter Voltage | VCEO | 12 | | Vdc |
| Collector-Base Voltage | V _{CBO} | | 25 | |
| Emitter-Base Voltage | VEBO | 4 | 4.0 | |
| Collector Current — Continuous | ľc | 1 | .0 | Adc |
| | | Each Transistor | Four Transistors Equal Power | |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 650 5.2 | 1250 10 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.0 8.0 | 3.0 24 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | | °C |

MPQ3303

CASE 646-05, STYLE 1 TO-116

QUAD SWITCHING TRANSISTOR

NPN SILICON

THERMAL CHARACTERISTICS

| Charac | teristic | Junction to Case | Junction to Ambient | Unit |
|--------------------|----------------------------------|---------------------|------------------------|------|
| Thermal Resistance | Each Die Effective, 4 Die | 125 41.6 | 193* 100* | °C/W |
| Coupling Factors | Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4 | 30 2.0 | 60 25 | % |

⁽¹⁾ R_{BJA} is measured with the device soldered into a typical printed circuit board.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------------------|----------|--------------|-------------|------|
| OFF CHARACTERISTICS | | - | | - | |
| Collector-Emitter Breakdown Voltage (IC = 10 mAdc, IB = 0) | V(BR)CEO | 12 | _ | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V _{(BR)CBO} | 25 | _ | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | V(BR)EBO | 4.0 | - | _ | Vdc |
| Collector Cutoff Current (VCE = 15 Vdc, VBE = 0) | ICES | 1 | _ | 100 | μAdc |
| ON CHARACTERISTICS | | | | | · |
| DC Current Gain (IC = 100 mAdc, VCE = 0.5 Vdc) (IC = 300 mAdc, VCE = 0.5 Vdc) | hFE | 30 40 | 45 55 | 200 | |
| Collector-Emitter Saturation Voltage (IC = 300 mAdc, IB = 30 mAdc) (IC = 1.0 Adc, IB = 0.1 Adc) | VCE(sat) | _ | 0.22 0.52 | 0.33 0.7 | Vdc |
| Base-Emitter Saturation Voltage (IC = 300 mAdc, IB = 30 mAdc) (IC = 1.0 Adc, IB = 0.1 Adc) | V _{BE(sat)} | | 0.87 1.04 | 1.1 1.4 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | L | | |
| Current-Gain — Bandwidth Product (IC = 100 mAdc, VCE = 5.0 Vdc, f = 100 MHz) | ŕτ | 400 | 500 | _ | MHz |
| Output Capacitance (VCB = 5.0 Vdc, I _E = 0, f = 1.0 MHz) | Cobo | _ | 5.0 | 10 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | C _{ibo} | _ | 22 | 30 | pF |
| SWITCHING CHARACTERISTICS | | | | • | |
| Turn-On Time (V _{CC} = 12 Vdc, I _C = 1.0 Adc, V _{BE(off)} = 4.0 Vdc, I _{B1} = 100 mAdc) | ton | _ | 12 | 15 | ns |
| Turn-Off Time (V _{CC} = 12 Vdc, I_C = 1.0 Adc, I_{B1} = I_{B2} = 100 mAdc) | toff | _ | 18 | 25 | ns |

MPQ3467

CASE 646-05, STYLE 1 TO-116

QUAD MEMORY DRIVER TRANSISTOR

PNP SILICON

Refer to MD3467 for graphs.

MAXIMUM RATINGS

| Rating | Symbol | Va | Unit | |
|---|------------------|--------------------|------------------------------------|----------------|
| Collector-Emitter Voltage | VCEO | 4 | Vdc | |
| Collector-Base Voltage | V _{СВО} | 4 | 10 | Vdc |
| Emitter-Base Voltage | VEBO | 5 | .0 | Vdc |
| Collector Current — Continuous | lc | 1 | Adc | |
| | | Each Transistor | Four Transistors Equal Power | |
| Total Device Dissipation @ T _A = 25°C(1) Derate above 25°C | PD | 650 5.2 | 1500 12 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.25 10 | 3.2 25.6 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, Tstg | – 55 to | °C | |

⁽¹⁾ Second Breakdown occurs at power levels greater than 2 times the power dissipation rating.

THERMAL CHARACTERISTICS

| Charac | teristic | R _{ØJC} Junction to Case | R _{ØJA} Junction to Ambient | Unit |
|--------------------|----------------------------------|-----------------------------------|--------------------------------------|--------|
| Thermal Resistance | Each Die Effective, 4 Die | 100 39 | 193 83.2 | °C/W |
| Coupling Factors | Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4 | 45 5.0 | 55 10 | % % |

| ELECTRICAL | CHARACTERISTICS | ITA = 25°C unless | otherwise noted \ |
|------------|-----------------|-------------------|-------------------|
| | | | |

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|------------------|-----|------|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, IB = 0) | V(BR)CEO | 40 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 40 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | V(BR)EBO | 5.0 | _ | | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, I _E = 0) | ІСВО | _ | _ | 200 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | [‡] EBO | - | _ | 200 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain(2) (IC = 500 mAdc, VCE = 1.0 Vdc) | pŁE | 20 | _ | _ | _ |
| Collector-Emitter Saturation Voltage(2) (IC = 500 mAdc, Ig = 50 mAdc) | VCE(sat) | _ | 0.23 | 0.5 | Vdc |
| Base-Emitter Saturation Voltage(2) (IC = 500 mAdc, Ig = 50 mAdc) | VBE(sat) | _ | 0.90 | 1.2 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 10 Vdc, f = 100 MHz) | ft | 125 | 190 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | _ | 10 | 25 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 100 kHz) | C _{ibo} | _ | 55 | 80 | pF |
| SWITCHING CHARACTERISTICS | | | | | |
| Turn-On Time (IC = 500 mAdc, IB1 = 50 mAdc) | ton | _ | _ | 40 | ns |
| Turn-Off Time (IC = 500 mAdc, IB1 = IB2 = 50 mAdc) | ^t off | _ | _ | 90 | ns |

(2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MPQ3546 For Specifications, See MHQ3546 Data.

MAXIMUM RATINGS

| WACKING III TATTINGO | | | | |
|--|----------------------|-------------------|---------------------------------------|----------------|
| Rating | Symbol | MPQ3725 | MPQ3725A | Unit |
| Collector-Emitter Voltage | VCEO | 40 | 50 | Vdc |
| Collector-Emitter Voltage | VCES | 60 | 70 | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | | Vdc |
| Collector Current — Continuous | lc | 1.0 | | Adc |
| | | One Transistor | Four Transistors Equal Power | |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 1.0 8.0 | 2.5 20 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | | ° |

THERMAL CHARACTERISTICS

| THE MINE OF THE | | | | |
|---|-------------------|-------------------|--------------------------------------|------|
| Characteristics | Symbol | M | Unit | |
| | | One Transistor | Effective For Four Transistors | |
| Thermal Resistance, Junction to Ambient(1) | R _Ø JA | 125 | 50 | °C/W |

MPQ3725,A

CASE 646-05, STYLE 1 TO-116

QUAD CORE DRIVER TRANSISTOR

NPN SILICON

Refer to MD3725 for graphs.

(1) R_{&JA} is measured with the device soldered into a typical printed circuit board.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|---------------------|------------------|------------|------------|------|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, I _B = 0) | MPQ3725 MPQ3725A | V(BR)CEO | 40 50 | = | _ | Vdc |
| Collector-Emitter Breakdown Voltage (I _C = 100 µAdc, V _{BE} = 0) | MPQ3725 MPQ3725A | V(BR)CES | 60 70 | _ | = | Vdc |
| Emitter-Base Breakdown Voltage (Ig = 10 μAdc, Ig = 0) | | V(BR)EBO | 5.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 40 Vdc, IE = 0) | | СВО | _ | _ | 0.5 | μAdc |
| ON CHARACTERISTICS(2) | | | | | | |
| DC Current Gain (I _C = 100 mAdc, V _{CE} = 1.0 Vdc) | MPQ3725 MPQ3725A | hFE | 35 40 | 75 80 | 200 | |
| $(I_C = 500 \text{ mAdc}, V_{CE} = 2.0 \text{ Vdc})$ | MPQ3725 MPQ3725A | | 25 30 | 45 50 | _ | |
| Collector-Emitter Saturation Voltage (IC = 500 mAdc, IB = 50 mAdc) | | VCE(sat) | - | 0.32 | 0.45 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 500 mAdc, I _B = 50 mAdc) | | VBE(sat) | 0.8 | 0.9 | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain Bandwidth Product (IC = 50 mAdc, VCE = 10 Vdc, f = 100 MHz) | MPQ3725 MPQ3725A | fτ | 250 200 | 275 250 | _ | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 100 kHz) | | Cobo | _ | 5.1 | 10 | pF |
| Input Capacitance (VBE = 0.5 Vdc, IC = 0, f = 100 kHz) | | C _{ibo} | _ | 62 | 80 | pF |

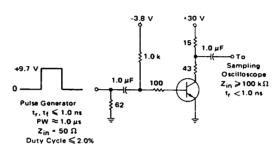
MPQ3725,A

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|--------|-----|-----|-----|-------------|
| SWITCHING CHARACTERISTICS | | | | • | |
| Turn-On Time (I _C = 500 mAdc, I _{B1} = 50 mAdc, V _{BE(off)} = 3.8 Vdc) | ton | _ | 20 | 35 | ns |
| Turn-Off Time (I _C = 500 mAdc, I _{B1} = I _{B2} = 50 mAdc) | toff | _ | 50 | 60 | ns |

(2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

FIGURE 1 - SWITCHING TIMES TEST CIRCUIT



| Rating | Symbol | Va | lue | Unit | | |
|--|-----------------------------------|--------------------|------------------------------------|----------------|----|-----|
| Collector-Emitter Voltage | VCEO | 40 | | Vdc | | |
| Collector-Base Voltage | VCBO | | 40 | | 40 | |
| Emitter-Base Voltage | VEBO | 9 | 5.0 | | | |
| Collector Current — Continuous | lc | 1.5 | | 1.5 | | Adc |
| | | Each Transistor | Four Transistors Equal Power | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 750 5.98 | 1700 13.6 | mW mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.25 10 | 3.2 25.6 | Watts mW/°C | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 55 t | °C | | | |

THERMAL CHARACTERISTICS

| Characte | eristic | Junction to Case | Junction to Ambient | Unit |
|-----------------------|------------------|---------------------|------------------------|------|
| Thermal Resistance(1) | Each Die | 100 | 167 | .c\M |
| | Effective, 4 Die | 39 | 73.5 | .c\M |
| Coupling Factors | Q1-Q4 or Q2-Q3 | 46 | 56 | % |
| | Q1-Q2 or Q3-Q4 | 5.0 | 10 | % |

MPQ3762

CASE 646-05, STYLE 1 TO-116

QUAD MEMORY DRIVER TRANSISTOR

PNP SILICON

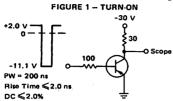
Refer to MD3467 for graphs.

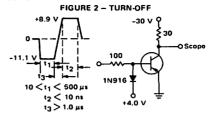
(1) R_{&JA} is measured with the device soldered into a typical printed circuit board.

| Characteristic | Symbol | Min ' | Тур | Max | Unit |
|---|----------------------|----------------|----------------|-------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, Ig = 0) | V(BR)CEO | 40 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 μAdc, I _E = 0) | V(BR)CBO | 40 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 μ Adc, IC = 0) | V(BR)EBO | 5.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0) | СВО | 1 | _ | 100 | nAdc |
| Emitter Cutoff Current (V _{EB} = 3.0 Vdc, I _C = 0) | ^I EBO | 1 | - | 100 | nAdc |
| ON CHARACTERISTICS(2) | | | | | _ |
| DC Current Gain (I _C = 150 mAdc, V _{CE} = 1.0 Vdc) (I _C = 500 mAdc, V _{CE} = 2.0 Vdc) (I _C = 1.0 Adc, V _{CE} = 2.0 Vdc) | hFE | 35 30 20 | 70 65 35 | = | _ |
| Collector-Emitter Saturation Voltage ($I_C = 500 \text{ mAdc}$, $I_B = 50 \text{ mAdc}$) ($I_C = 1.0 \text{ Adc}$, $I_B = 100 \text{ mAdc}$) | VCE(sat) | 11 | 0.3 0.6 | 0.55 0.9 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 500 mAdc, I _B = 50 mAdc) (I _C = 1.0 Adc, I _B = 100 mAdc) | V _{BE(sat)} | - | 0.9 1.0 | 1.25 1.4 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product(2) {IC = 50 mAdc, VCE = 10 Vdc, f = 100 MHz} | fτ | 150 | 275 | _ | MHz |
| Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 100 kHz) | C _{obo} | _ | 9.0 | 15 | pF |
| Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 100 kHz) | C _{ibo} | _ | 55 | 80 | pF |
| SWITCHING CHARACTERISTICS | | | | | |
| Turn-On Time $(V_{CC} = 30 \text{ Vdc}, I_C = 1.0 \text{ Adc}, I_{B1} = 100 \text{ mAdc}, V_{BE(off)} = 2.0 \text{ Vdc})$ | ton | _ | _ | 50 | ns |
| Turn-Off Time (V _{CC} = 30 Vdc, I_C = 1.0 Adc, I_{B1} = I_{B2} = 100 mAdc) | toff | | _ | 120 | ns |

SMALL-SIGNAL DEVICES

EQUIVALENT TEST CIRCUITS





| Rating | Symbol | MPQ3798 | MPQ3799 | Unit |
|--|----------------------|--------------------|------------------------------------|---------------|
| Collector-Emitter Voltage | VCEO | 40 | 60 | Vdc |
| Collector-Base Voltage | VCBO | 6 | 50 | Vdc |
| Emitter-Base Voltage | VEBO | 5 | .0 | Vdc |
| Collector Current — Continuous IC | | 5 | 50 | mAdc |
| | | Each Transistor | Four Transistors Equal Power | |
| Total Device Dissipation @ TA = 25°C(1) Derate above 25°C | PD | 0.5 4.0 | 0.9 7.2 | Watt mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 0.825 6.7 | 2.4 19.2 | Watts m/°C |
| Operating and Storage Junction Temperature Range | Tj, T _{stg} | -55 to +150 | | °C |

⁽¹⁾ Second breakdown occurs at power levels greater than 3 times the power dissipation rating.

THERMAL CHARACTERISTICS

| Characteristic | | R _{ØJC} Junction to Case | R _{ØJA} Junction to Ambient | Unit |
|--------------------|------------------|-----------------------------------|--|------|
| Thermal Resistance | Each Die | 151 | 250 | °C/W |
| | Effective, 4 Die | 52 | 139 | °C/W |
| Coupling Factors | Q1-Q4 or Q2-Q3 | 34 | 70 | % |
| · - | Q1-Q2 or Q3-Q4 | 2.0 | 26 | % |

MPQ3798 MPQ3799

CASE 646-05, STYLE 1 TO-116

QUAD AMPLIFIER TRANSISTOR

PNP SILICON

Refer to 2N3810 for graphs.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|--------------------|----------------------|------------|--------------|-------------------|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage(2) (I _C = 10 mAdc, I _B = 0) | MPQ3798 MPQ3799 | V(BR)CEO | 40 60 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | | V(BR)CBO | 60 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 µAdc, IC = 0) | | V(BR)EBO | 5.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 50 Vdc, (E = 0) | | ICBO | - | _ | 10 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | | IEBO | _ | - | 20 | nAdc |
| ON CHARACTERISTICS(2) | | | | | | |
| DC Current Gain (I _C = 10 μ Adc, V _{CE} = 5.0 Vdc) | MPQ3798 MPQ3799 | hFE | 100 225 | _ | _ | _ |
| $(I_C = 100 \ \mu Adc, V_{CE} = 5.0 \ Vdc)$ | MPQ3798 MPQ3799 | | 150 300 | _ | - - | |
| (I _C = 500 μAdc, V _{CE} = 5.0 Vdc) | MPQ3798 MPQ3799 | | 150 300 | _ | _ | |
| (IC = 10 mAdc, VCE = 5.0 Vdc) | MPQ3798 MPQ3799 | | 125 250 | | 11 | |
| Collector-Emitter Saturation Voltage (I _C = 100 µAdc, I _B = 10 µAdc) (I _C = 1.0 mAdc, I _B = 100 µAdc) | | VCE(sat) | _ | 0.12 0.07 | 0.2 0.25 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 100 μ Adc, I _B = 10 μ Adc) (I _C = 1.0 mAdc, I _B = 100 μ Adc) | | V _{BE(sat)} | | 0.62 0.68 | 0.7 0.8 | Vdc |

MPQ3798,99

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|------------------|-----|------------|-----|------|
| SMALL-SIGNAL CHARACTERISTICS | | | • | • | |
| Current-Gain — Bandwidth Product (IC = 1.0 mAdc, VCE = 5.0 Vdc, f = 100 MHz) | ŕτ | 60 | 250 | _ | MHz |
| Output Capacitance (VCB = 5.0 Vdc, IE = 0, f = 100 kHz) | C _{obo} | _ | 2.1 | 4.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 100 kHz) | C _{ibo} | _ | 5.5 | 8.0 | pF |
| Noise Figure (I _C = 100 µAdc, V _{CE} = 10 Vdc, R _S = 3.0 kohms, MPQ3798 f = 10 Hz to 15.7 kHz) MPQ3799 | NF | | 2.5 1.5 | = | dB |

⁽²⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| MAXIMOM TATHEGO | | | | | | |
|--|----------------------|--------------------|------------------------------------|----------------|--|-----|
| Rating | Symbol | Value | | Unit | | |
| Collector-Emitter Voltage | VCEO | 40 | | Vdc | | |
| Collector-Base Voltage | VCBO | 60 | | 60 | | Vdc |
| Emitter-Base Voltage | VEBO | 6.0 | | Vdc | | |
| Collector Current — Continuous | | | mAdc | | | |
| | | Each Transistor | Four Transistors Equal Power | | | |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 500 4.0 | 900 7.2 | mW mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 825 6.7 | 2.4 19.2 | Watts mW/°C | | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | | °C | | |

THERMAL CHARACTERISTICS

OFF CHARACTERISTICS

| Charac | teristic | Junction to Case | Junction to Ambient | Unit |
|--------------------|------------------------------|---------------------|------------------------|------|
| Thermal Resistance | Each Die Effective, 4 Die | 151 52 | 250 139 | °C/W |
| Coupling Factors | Q1-Q4 or Q2-Q3 | 34 | 70 26 | % |

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic

MPQ3904

CASE 646-05, STYLE 1 TO-116

QUAD AMPLIFIER/SWITCHING TRANSISTOR

NPN SILICON

Refer to 2N3904 for graphs.

Тур

Max

Unit

Min

Symbol

ton

toff

| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 40 | _ | | Vdc |
|---|------------------|----------------|------------------|------|------|
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 60 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | V(BR)EBO | 6.0 | | | Vdc |
| Collector Cutoff Current (VCB = 40 Vdc, $I_E = 0$) | ІСВО | - | _ | 50 | nAdc |
| Emitter Cutoff Current (VBE = 40 Vdc, IC = 0) | IEBO | _ | _ | 50 | nAdc |
| ON CHARACTERISTICS(1) | , | | | | • |
| DC Current Gain (I _C = 0.1 mAdc, V _{CE} = 1.0 Vdc) (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) | hFE | 30 50 75 | 90 160 200 | = | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | VCE(sat) | - | 0.1 | 0.2 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | VBE(sat) | _ | 0.65 | 0.85 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | 1 | | | • | |
| Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 100 MHz) | ĺΤ | 250 | 300 | - | MHz |
| Output Capacitance (VCB = 5.0 Vdc, Ig = 0, f = 140 kHz) | C _{obo} | _ | 2.0 | 4.0 | ρF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 140 kHz) | Cibo | _ | 4.0 | 8.0 | pF |

 $(I_C = 10 \text{ mAdc}, I_{B1} = I_{B2} = 1.0 \text{ mAdc})$

(IC = 10 mAdc, VBE = 0.5 Vdc, IB1 = 1.0 mAdc)

SWITCHING CHARACTERISTICS

Turn-On Time

Turn-Off Time

37

136

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MPQ3906

CASE 646-05, STYLE 1 TO-116

QUAD AMPLIFIER/SWITCH TRANSISTOR

PNP SILICON

Refer to 2N3906 for graphs.

MAXIMUM RATINGS

| THE STATE OF THE S | | | | | | |
|--|-----------------------------------|--------------------|------------------------------------|----------------|--|------|
| Rating | Symbol | Va | lue | Unit | | |
| Collector-Emitter Voltage | VCEO | 40 | | 40 | | Vdc |
| Collector-Base Voltage | VCBO | 40 | | 40 | | Vdc |
| Emitter-Base Voltage | VEBO | 5.0 | | 5.0 | | Vdc |
| Collector Current — Continuous | lc | 200 | | 200 | | mAdc |
| | | Each Transistor | Four Transistors Equal Power | | | |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 500 4.0 | 900 7.2 | mW mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 825 6.7 | 2.4 19.2 | Watts mW/°C | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to | + 150 | °C | | |

THERMAL CHARACTERISTICS

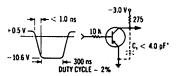
| Characteristic | | Junction to Case | Junction to Ambient | Unit |
|--------------------|----------------------------------|---------------------|------------------------|--------|
| Thermal Resistance | Each Die Effective, 4 Die | 151 52 | 250 139 | *C/W |
| Coupling Factors | Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4 | 34 2.0 | 70 26 | % % |

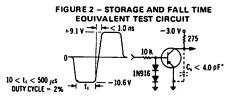
| ELECTRICAL | CHARACTERISTICS IT | 25°C unless otherwise noted.) |
|----------------|-----------------------|-------------------------------|
| PI PELI RICIAL | CHARACTERISTICS (IA = | 25" LIDIESS OTRERWISE ROTECT |

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|----------------------|----------------|-------------------|----------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 40 | _ | 1 | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 40 | _ | ı | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 5.0 | | 1 | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, IE = 0) | СВО | - | _ | 50 | nAdc |
| Emitter Cutoff Current (VBE = 4.0 Vdc, IC = 0) | ¹ EBO | 1 | _ | 50 | nAdc |
| ON CHARACTERISTICS(1) | | | | | |
| DC Current Gein (I _C = 0.1 mAdc, V _{CE} = 1.0 Vdc) (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) | μ LE | 40 60 75 | 160 180 200 | - - | _ |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | V _{CE(sat)} | | 0.1 | 0.25 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | V _{BE(sat)} | _ | 0.65 | 0.85 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz) | fT | 200 | 250 | | MHz |
| Output Capacitance (VCB = 5.0 Vdc, IE = 0, f = 140 kHz) | C _{obo} | | 3.3 | 4.5 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 140 kHz) | C _{ibo} | _ | 4.8 | 10 | pF |
| SWITCHING CHARACTERISTICS | | | | | |
| Turn-On Time (IC = 10 mAdc, VBE(off) = 0.5 Vdc, IB1 = 1.0 mAdc) | ton | _ | 43 | _ | ns |
| Turn-Off Time (I _C = 10 mAdc, I _{B1} = I _{B2} = 1.0 mAdc) | toff | _ | 155 | – | ns |

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

FIGURE 1 – DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT





*Total shunt capacitance of test jig and connectors

MPQ6001 MPQ6002

TYPE 1

MPQ6501 MPQ6502

TYPE 2

CASE 646-05

QUAD COMPLEMENTARY PAIR TRANSISTOR

PNP/NPN SILICON

MAXIMUM RATINGS

| MAXIMUM KATINGS | | | | |
|--|----------------------|--------------------|------------------------------------|----------------|
| Rating | Symbol | Va | lue | Unit |
| Collector-Emitter Voltage | VCEO | 3 | 0 | Vdc |
| Collector-Base Voltage | VCBO | 6 | iO | Vdc |
| Emitter-Base Voltage | VEBO | 5 | .0 | Vdc |
| Collector Current — Continuous | lc | 5 | 00 | mAdc |
| | | Each Transistor | Four Transistors Equal Power | |
| Total Device Dissipation @ TA = 25°C(1) MPQ6001, MPQ6002, MPQ6501, MPQ6502 Derate above 25°C MPQ6001, MPQ6002, MPQ6501, | PD | 0.65 | 1.25 | Watts mW/°C |
| MPQ6502 | | 5.18 | 10 | |
| Total Device Dissipation @ T _C = 25°C MPQ6001, MPQ6002, MPQ6501, | PD | - | | Watts |
| MPQ6502 Derate above 25°C MPQ6001, MPQ6002, MPQ6501, | | 1.0 | 3.0 | mW/°C |
| MPQ6502 | | 8.0 | 24 | |
| Operating and Storage Junction Temperature Range | Tj, T _{stg} | – 55 to | + 150 | °C |

THERMAL CHARACTERISTICS

| | Characteristic | Junction to Case | Junction to Ambient | Unit |
|--------------------------------|------------------------------------|---------------------|------------------------|------|
| Thermal Resistance Each Die | MPQ6001, MPQ6002, MPQ6501, MPQ6502 | 125 | 193 | °C/W |
| Effective, 4 Die | MPQ6001, MPQ6002, MPQ6501, MPQ6502 | 41.6 | 100 | |
| Coupling Factors | | 30 | 60 | % |
| | MPQ6001, MPQ6002 | 30 | 60 | |
| Q1-Q4 or Q2-Q3 | MPQ6501, MPQ6502 | 30 | 60 | 1 |
| | · | 30 | 60 | |
| | MPQ6001, MPQ6002 | | | |
| Q1-Q2 or Q3-Q4 | MPQ6501, MPQ6502 | 20 | 24 | Į |
| | | 20 | 24 | 1 |
| | | 20 | 24 | 1 |
| | | 2.0 | 24 | 1 |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characterist | ic | Symbol | Min | Тур | Max | Unit |
|---|--------------------------------------|----------|-----------|-----|-----|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage(2) (IC | = 10 mAdc, Ig = 0) | V(BR)CEO | 30 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 |) μAdc, IE = 0) | V(BR)CBO | 60 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 10 | μAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE | = 0) | ІСВО | _ | _ | 30 | nAdc |
| Emitter Cutoff Current (VEB = 3.0 Vdc, IC | = O) | IEBO | _ | - | 30 | nAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain(2) (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) | MPQ6001, MPQ6501 MPQ6002, MPQ6502 | hFE | 25 50 | _ | = | _ |
| (I _C = 10 mAdc, V _{CE} = 10 Vdc) | MPQ6001, MPQ6501 MPQ6002, MPQ6502 | | 35 75 | _ | _ | |
| (IC = 150 mAdc, VCE = 10 Vdc) | MPQ6001, MPQ6501 MPQ6002, MPQ6502 | | 40 100 | = | = | |
| (IC = 300 mAde, VCE = 10 Vdc) | MPQ6001, MPQ6501 MPQ6002, MPQ6502 | | 20 30 | = | _ | |

MPQ6001

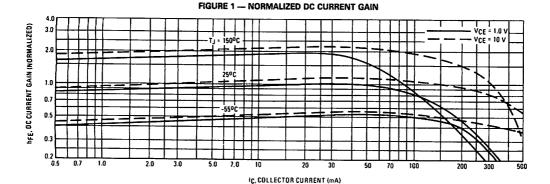
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

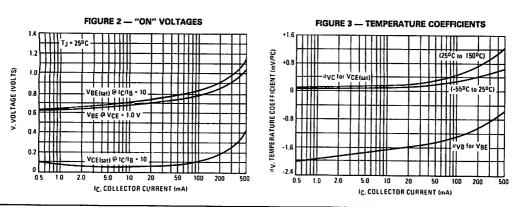
| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|------------|----------------------|-----|------------|------------|----------|
| Collector-Emitter Saturation Voltage(2) (IC = 150 mAdc, IB = 15 mAdc) (IC = 300 mAdc, IB = 30 mAdc) | | VCE(sat) | _ | = | 0.4 | Vdc |
| Base-Emitter Saturation Voltage(2) (I _C = 150 mAdc, I _B = 15 mAdc) (I _C = 300 mAdc, I _B = 30 mAdc) | | V _{BE(sat)} | = | = | 1.3 2.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | <u> </u> |
| Current-Gain — Bandwidth Product(2) (IC = 50 mAdc, VCE = 20 Vdc, f = 100 MHz) | | ĺΤ | 200 | 350 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 100 kHz) | PNP NPN | C _{obo} | = | 6.0 4.5 | 8.0 8.0 | pF |
| Input Capacitance (VEB = 2.0 Vdc, I _C = 0, f = 100 kHz) | PNP NPN | C _{ibo} | | 20 17 | 30 30 | рF |
| SWITCHING CHARACTERISTICS | | | | | | L |
| Turn-On Time ($V_{CC} = 30 \text{ Vdc}$, $V_{BE} = 0.5 \text{ Vdc}$, $I_{C} = 150 \text{ mAdc}$, $I_{B1} = 15 \text{ mAdc}$, Figure 1) | | ton | _ | 30 | - | ns |
| Turn-Off Time (V _{CC} = 30 Vdc, I _C = 150 mAdc, | | ^t off | - | 225 | - | ns |

⁽¹⁾ Second Breakdown occurs at power levels greater than 3 times the power dissipation rating.

IB1 = IB2 = 15 mAdc)

NPN DATA

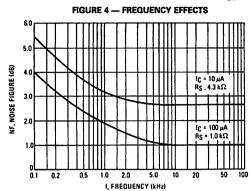


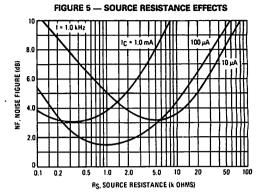


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⁽²⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

NOISE FIGURE (V_{CE} = 10 Vdc, T_A = 25^oC)





| MAXIMOM NATINGS | | | | |
|--|----------------------|--------------------|------------------------------------|----------------|
| Rating | Symbol | MPQ6100 MPQ6600 | MPQ6100A MPQ6600A | Unit |
| Collector-Emitter Voltage | VCEO | 40 | 45 | Vdc |
| Collector-Base Voltage | VCBO | . (| 50 | Vdc |
| Emitter-Base Voltage | V _{EBO} | 5 | 5.0 | Vdc |
| Collector Current — Continuous IC | | ű | mAdc | |
| | | Each Transistor | Four Transistors Equal Power | |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 500 4.0 | 900 7.2 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 0.825 6.7 | 2.4 19.2 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | | ౡ |

THERMAL CHARACTERISTICS

| Characte | eristic | Junction to Case | Junction to Ambient | Unit |
|-----------------------|----------------------------------|---------------------|------------------------|--------|
| Thermal Resistance(1) | Each Die Effective, 4 Die | 151 52 | 250 139 | °C/W |
| Coupling Factors | Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4 | 34 2.0 | 70 26 | % % |

MPQ6100,A TYPE 1 MPQ6600,A TYPE 2

CASE 646-05 TO-116

QUAD
COMPLEMENTARY PAIR
TRANSISTOR

PNP/NPN SILICON

Refer to MHQ2483 for NPN Curves.
Refer to MHQ3798 for PNP Curves.

(1) Raja is measured with the device soldered into a typical printed circuit board.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|--------------------------------|----------------------|-----------|-------------|------------|------|
| OFF CHARACTERISTICS | | | | · · · · · · | | |
| Collector-Emitter Breakdown Voltage(2) (I _C = 10 mAdc, I _B = 0) | MPQ6100,6600 MPQ6100A,6600A | V(BR)CEO | 40 45 | | = | Vdc |
| Collector-Base Breakdown Voltage (I _C = 10 μAdc, I _E = 0) | | V(BR)CBO | 60 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 50 Vdc, IE = 0) | | ІСВО | _ | _ | 10 | nAdc |
| ON CHARACTERISTICS(2) | | | | L | | |
| DC Current Gain (I _C = 100 μAdc, V _{CE} = 5.0 Vdc) | MPQ6100,6600 MPQ6100A,6600A | pŁE | 50 100 | = | _ | _ |
| $(I_C = 500 \ \mu Adc, V_{CE} = 5.0 \ Vdc)$ | MPQ6100,6600 MPQ6100A,6600A | | 75 150 | = | | |
| $(I_C = 1.0 \text{ mAdc}, V_{CE} = 5.0 \text{ Vdc})$ | MPQ6100,6600 MPQ6100A,6600A | | 75 150 | _ | _ | |
| (IC = 10 mAdc, VCE = 5.0 Vdc) | MPQ6100,6600 MPQ6100A,6600A | | 60 125 | _ | _ | |
| Collector-Emitter Saturation Voltage (IC = 1.0 mAdc, Ig = 100 μAdc) | | V _{CE(sat)} | - | - | 0.25 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 1.0 mAdc, I _B = 100 μAdc) | | V _{BE(sat)} | _ | - | 8.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product (I _C = 500 μAdc, V _{CE} = 5.0 Vdc, f = 20 MHz) | | fT | 50 | _ | _ | MHz |
| Output Capacitance {VCB = 5.0 Vdc, I _E = 0, f = 100 kHz} | PNP NPN | C _{obo} | _ | 1.2 1.8 | 4.0 4.0 | pF |

MPQ6100,A, MPQ6600,A

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Symbol | Min | Тур | Max | Unit |
|--------|------------------|------------------|------------------|-----------------------------|
| Cibo | İ | | | рF |
| | | _ | 8.0 | \ |
| | _ | _ | 8.0 | |
| NF | _ | 4.0 | _ | dB |
| | | | | <u> </u> |
| | C _{ibo} | C _{ibo} | C _{ibo} | C _{ibo} 8.0 8.0 |

(2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

| MAXIMON NATINGS | | | | | | |
|---|-----------------------------------|-------------|-------------------------|-------------|--|-----|
| Rating | Symbol | Va | ilue | Unit | | |
| Collector-Emitter Voltage MPQ6426 MPQ6427 | VCEO | 30 40 | | | | Vdc |
| Collector-Base Voltage MPQ6426 MPQ6427 | V _{СВО} | 40 50 | | | | Vdc |
| Emitter-Base Voltage | V _{EBO} | 12 | | 12 | | Vdc |
| Collector Current — Continuous | lc | 500 | | mAdc | | |
| _ | | Each Die | Four Die Equal Power | | | |
| Total Device Dissipation @ T _A = 25°C(1) Derate above 25°C | PD | 500 4.0 | 900 7.2 | mW mW/°C | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 825 6.7 | 2400 19.2 | mW mW/°C | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | | °C | | |

⁽¹⁾ Second Breakdown occurs at power levels greater than 3 times the power dissipation rating.

MPQ6426 MPQ6427

CASE 646-05, STYLE 1 TO-116

QUAD DARLINGTON TRANSISTOR

NPN SILICON

THERMAL CHARACTERISTICS

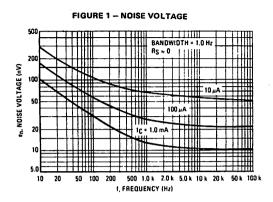
| Charac | teristic | Junction to Case | Junction to Ambient | Unit |
|--------------------|----------------------------------|---------------------|------------------------|------|
| Thermal Resistance | Each Die Effective, 4 Die | 151 52 | 250 139 | °C/W |
| Coupling Factors | Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4 | 34 2.0 | 70 26 | % |

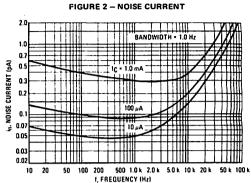
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

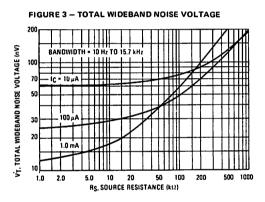
| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------|----------------------|----------------|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (I _C = 10 mAdc, I _B = 0) | MPQ6426 MPQ6427 | V(BR)CEO | 30 40 | | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μ Adc, IE = 0) | MPQ6426 MPQ6427 | V(BR)CBO | 40 50 | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | | V _{(BR)EBO} | 12 | _ | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, I _E = 0) | | ICBO | _ | 100 | nAdc |
| Emitter Cutoff Current (VBE = 10 Vdc, I _C = 0) | | IEBO | - | 100 | nAdc |
| ON CHARACTERISTICS(2) | | | | | |
| DC Current Gain (I _C = 10 mAdc, V _{CE} = 5.0 Vdc) (I _C = 100 mAdc, V _{CE} = 5.0 Vdc) | | htE | 5000 10,000 | = | _ |
| Collector-Emitter Saturation Voltage (IC = 100 mAdc, Ig = 0.1 mAdc) | | V _{CE(sat)} | - | 1.5 | Vdc |
| Base-Emitter On Voltage (IC = 100 mAdc, VCE = 5.0 Vdc) | | VBE(on) | | 2.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (I _C = 10 mAdc, V _{CE} = 5.0 Vdc, f = 100 MHz) | | fΤ | 125 | _ | MHz |
| Output Capacitance (VCB = 10 Vdc, I_E = 0, f = 100 kHz) | | Copo | - | 8.0 | pF |
| Input Capacitance (VBE = 0.5 Vdc, I _C = 0, f = 100 kHz) | | C _{ibo} | _ | 15 | pF |
| 0 D. L. T D. L 140 M | | | | | |

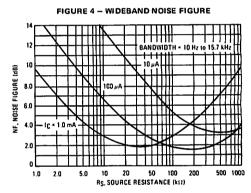
(2) Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

NOISE CHARACTERISTICS (VCE = 5.0 Vdc, TA = 25°C)

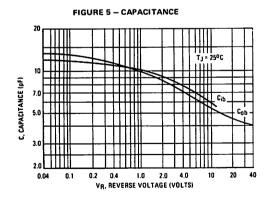


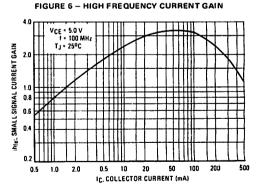






DYNAMIC CHARACTERISTICS





MAXIMUM RATINGS

| Rating | Symbol | Va | Unit | |
|---|----------------------|--------------------|------------------------------------|-------------|
| Collector-Emitter Voltage | VCEO | 40 | | Vdc |
| Collector-Base Voltage | V _{CBO} | 4 | 10 | Vdc |
| Emitter-Base Voltage | VEBO | 5 | .0 | Vdc |
| Collector Current — Continuous | lc | 200 | | mAdc |
| | | Each Transistor | Four Transistors Equal Power | |
| Total Device Dissipation @ T _A = 25°C(1) Derate above 25°C | PD | 500 4.0 | 900 7.2 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 825 6.7 | 2400 19.2 | mW mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | | ပိ |

⁽¹⁾ Second breakdown occurs at power levels greater than 3 times the power dissipation rating.

THERMAL CHARACTERISTICS

| Charac | Characteristic | | Junction to Ambient | Unit | |
|--------------------|----------------------------------|-----------|------------------------|--------|--|
| Thermal Resistance | Each Die Effective, 4 Die | 151 52 | 250 139 | °C/W | |
| Coupling Factors | Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4 | 34 2.0 | 70 26 | % % | |

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic

MPQ6700

CASE 646-05, TYPE 2 TO-116

QUAD COMPLEMENTARY PAIR TRANSISTOR

PNP/NPN SILICON

Symbol

Cibo

Min

Max

Unit

ρF

| OFF CHARACTERISTICS | | | | |
|---|----------------------|----------------|------|------|
| Collector-Emitter Breakdown Voltage(2) (IC = 10 mAdc, Ig = 0) | V(BR)CEO | 40 | _ | Vđc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V(BR)CBO | 40 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 µAdc, I _C = 0) | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 30 Vdc, 1g = 0) | СВО | _ | 50 | nAdc |
| Emitter Cutoff Current (VEB = 4.0 Vdc, IC = 0) | IEBO | _ | 50 | nAdc |
| ON CHARACTERISTICS(2) | | | | |
| DC Current Gain (IC = 0.1 mAdc, VCE = 1.0 Vdc) (IC = 1.0 mAdc, VCE = 1.0 Vdc) (IC = 10 mAdc, VCE = 1.0 Vdc) | hpe | 30 50 70 | | - |
| Collector-Emitter Saturation Voltage (IC = 10 mAdc, Ig = 1.0 mAdc) | VCE(sat) | _ | 0.25 | Vdc |
| Base-Emitter Saturation Voltage (IC = 10 mAdc, IB = 1.0 mAdc) | V _{BE(sat)} | : . — | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product(2) (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz) | fτ | 200 | _ | MHz |
| Output Capacitance (VCB = 5.0 Vdc, I_E = 0, f = 100 kHz) | C _{obo} | | 4.5 | pF |
| | | | , | |

(2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

(VEB = 0.5 Vdc, IC = 0, f = 100 kHz)

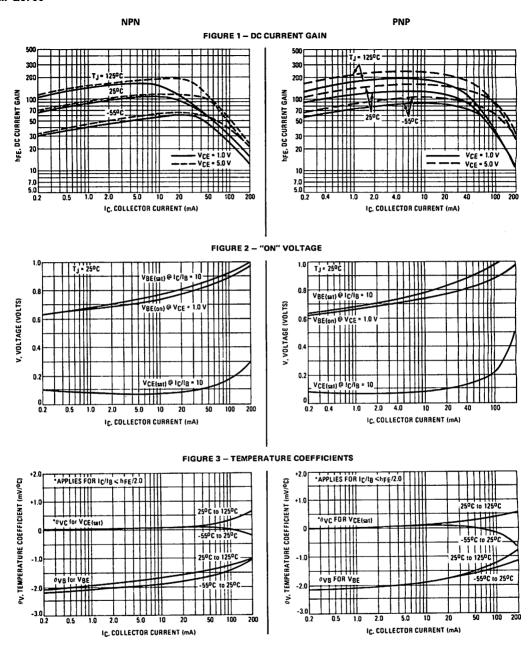
Input Capacitance

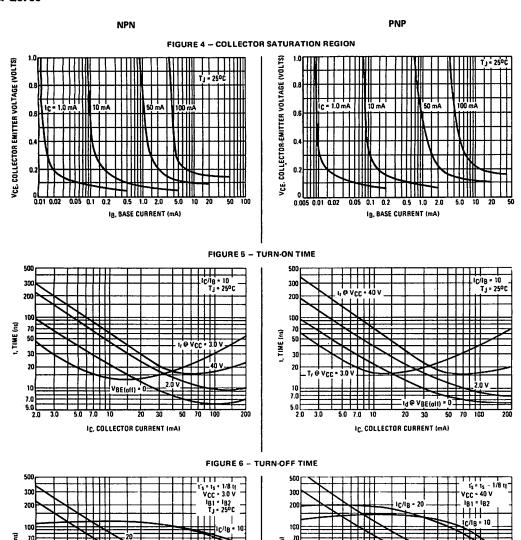
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8.0

PNP

NPN







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50

30

20

ti @ (c/lg = 10

IC. COLLECTOR CURRENT (mA)

70 TIME (ns)

50

30

20

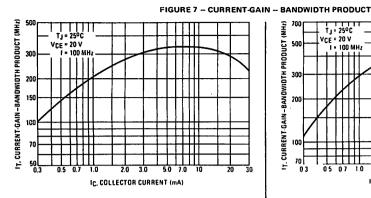
14@ IC/IB = 10

IC. COLLECTOR CURRENT (mA)

IC/18 - 20



PNP



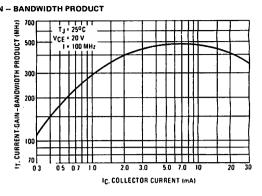
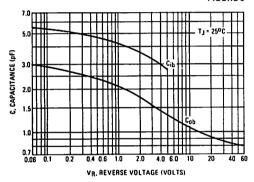
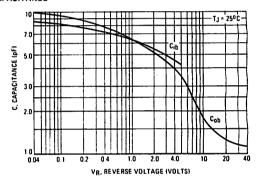


FIGURE 8 - CAPACITANCE





MAXIMUM RATINGS

| Rating | Symbol | Value | | Unit |
|--|-----------------------------------|--------------------|------------------------------------|-------------|
| Collector-Emitter Voltage | VCEO | 30 | | Vdc |
| Collector-Base Voltage | VCBO | 30 | | Vdc |
| Emitter-Base Voltage | VEBO | 4 | .0 | Vdc |
| Collector Current — Continuous | lc | 2 | mAdc | |
| | | Each Transistor | Four Transistors Equal Power | |
| Total Device Dissipation @ TA = 25°C(1) Derate above 25°C | PD | 500 4.0 | 900 7.2 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 825 6.7 | 2400 19.2 | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 t | င | |

⁽¹⁾ Second Breakdown occurs at power levels greater than 3 times the power dissipation rating.

THERMAL CHARACTERISTICS

| Characteristic | | Junction to Case | Junction to Amblent | Unit |
|--------------------|----------------------------------|---------------------|------------------------|--------|
| Thermal Resistance | Each Die Effective, 4 Die | 151 52 | 250 139 | °C/W |
| Coupling Factors | Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4 | 34 2.0 | 70 26 | % % |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

MPQ6842

CASE 646-05, TYPE 2 TO-116

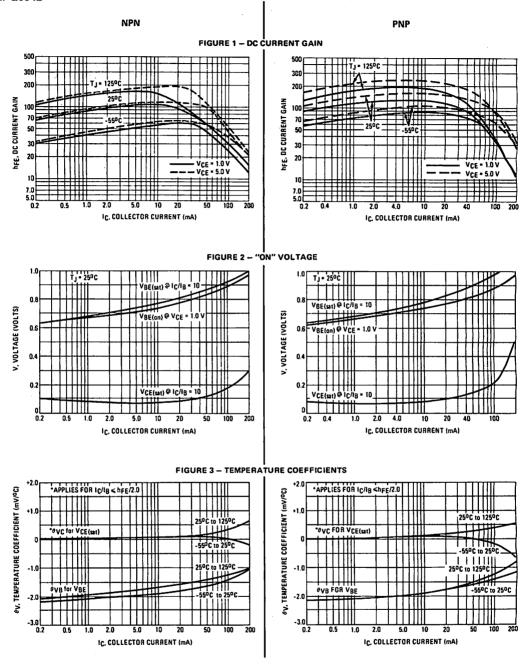
QUAD COMPLEMENTARY PAIR TRANSISTOR

PNP/NPN SILICON

| Characteristic | Symbol | Min | Тур | Max | Unit | |
|--|-----------------------|----------------|------------|-----------|------|--|
| OFF CHARACTERISTICS | | | | | • | |
| Collector-Emitter Breakdown Voltage(2) (I _C = 10 mAdc, I _B = 0) | V(BR)CEO | 30 | _ | | Vdc | |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | V _(BR) CBO | 30 | _ | _ | Vdc | |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | V(BR)EBO | 4.0 | _ | | Vdc | |
| Collector Cutoff Current (V _{CB} = 20 Vdc, I _E = 0) | ІСВО | | - | 50 | nAdc | |
| Emitter Cutoff Current (VEB = 3.0 Vdc, IC = 0) | l _{EBO} | _ | _ | 50 | nAdc | |
| ON CHARACTERISTICS(2) | | | | | | |
| DC Current Gain ($I_C = 0.5 \text{ mAdc}$, $V_{CE} = 1.0 \text{ Vdc}$) ($I_C = 1.0 \text{ mAdc}$, $V_{CE} = 1.0 \text{ Vdc}$) ($I_C = 10 \text{ mAdc}$, $V_{CE} = 1.0 \text{ Vdc}$) | hFE | 30 50 70 | | = | - | |
| Collector-Emitter Saturation Voltage (I _C = 0.5 mAdc, I _B = 0.05 mAdc, 0° C \leq T \leq 70°C) | VCE(sat) | _ | 0.05 | 0.15 | Vdc | |
| Base-Emitter Saturation Voltage (I _C = 0.5 mAdc, I _B = 0.05 mAdc) | V _{BE(sat)} | _ | 0.65 | 0.9 | Vdc | |
| SMALL-SIGNAL CHARACTERISTICS | | | | • | • | |
| Current-Gain — Bandwidth Product(2) (I _C = 10 mAdc, V _{CE} = 20 Vdc, f = 100 MHz) | fΤ | 200 | 350 | _ | MHz | |
| Output Capacitance (VCB = 5.0 Vdc, IE = 0, f = 100 kHz) | C _{obo} | _ | 3.0 | 4.5 | pF | |
| Input Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 100 kHz) PNP NPN | C _{ibo} | = | 5.0 4.0 | 10 8.0 | pF | |
| SWITCHING CHARACTERISTICS (TA = 25°C, V _{CC} = 5.0 Vdc) | | | | | | |
| Propagation Delay Time (50% Points TP1 to TP3) (50% Points TP2 to TP4) | tPLH tPHL | _ | 15 6.0 | 25 15 | ns | |
| Rise Time (0.3 V to 4.7 V, TP3 or TP4) | t _r | 5.0 | 25 | 35 | ns | |
| Fall Time | te | 5.0 | 10 | 20 | 08 | |

(4.7 V to 0.3 V, TP3 or TP4)

(2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.



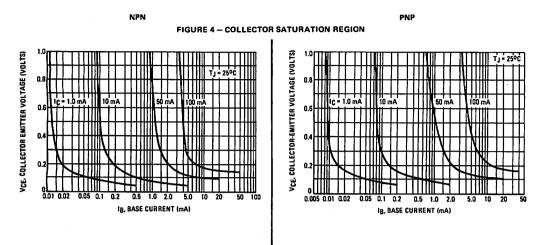
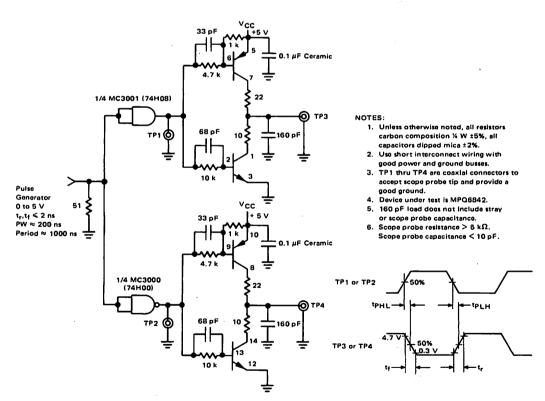


FIGURE 5 - SWITCHING TIMES TEST CIRCUIT AND WAVEFORMS



MPQ7041 MPQ7042 MPQ7043

CASE 646-05, STYLE 1 TO-116

QUAD AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MPQ7051 for graphs.

MAXIMUM RATINGS

| MAXIMON PATINGS | | | | | | |
|--|-----------------------------------|-------------|---------|-------------------|----------------|--|
| Rating | Symbol | MPQ7041 | MPQ7042 | MPQ7043 | Unit | |
| Collector-Emitter Voltage | VCEO | 150 | 200 | 250 | Vdc | |
| Collector-Base Voltage | VCBO | 150 | 200 | 250 | Vdc | |
| Emitter-Base Voltage | VEBO | | 5.0 | | Vdc | |
| Collector Current — Continuous | lc | 500 | | | mAdc | |
| · | | Each Die | | ur Die I Power | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 750 5.98 | | 700 13.6 | mW mW/°C | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.25 10 | 2 | 3.2 25.6 | Watts mW/°C | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | | | ో | |

THERMAL CHARACTERISTICS

| Characteristic | | Junction to Case | Junction to Ambient | Unit |
|--------------------|----------------------------------|---------------------|------------------------|--------|
| Thermal Resistance | Each Die Effective, 4 Die | 100 39 | 167 73.5 | °C⁄W |
| Coupling Factors | Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4 | 46 5.0 | 56 10 | % % |

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|-------------------------------|----------------------|-------------------|----------------|-------------------|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, Ig = 0) | MPQ7041 MPQ7042 MPQ7043 | V(BR)CEO | 150 200 250 | = | 1 - 1 | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 µAdc, I _E = 0) | MPQ7041 MPQ7042 MPQ7043 | V(BR)CBO | 150 200 250 | _ _ _ | 111 | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | - | Vdc |
| Collector Cutoff Current (VCB = 120 Vdc, $ E=0\rangle$ (VCB = 150 Vdc, $ E=0\rangle$ (VCB = 180 Vdc, $ E=0\rangle$ | MPQ7041 MPQ7042 MPQ7043 | ICBO | _ | _ _ _ | 100 100 100 | nAdc |
| ON CHARACTERISTICS | | | , | , | | , |
| DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc) (I _C = 30 mAdc, V _{CE} = 10 Vdc) | | hFE | 25 40 40 | 45 60 80 | _ _ _ | _ |
| Collector-Emitter Saturation Voltage (IC = 20 mAdc, IB = 2.0 mAdc) | | V _{CE(sat)} | _ | 0.3 | 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 20 mAdc, IB = 2.0 mAdc) | | V _{BE(sat)} | _ | 0.7 | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz) | | fT | 50 | 80 | _ | MHz |
| Output Capacitance (VCB = 20 Vdc, I _E = 0, f = 1.0 MHz) | | C _{obo} | | 2.5 | 5.0 | pF |
| Input Capacitance (VEB = 3.0 Vdc, IC = 0, f = 1.0 MHz) | | C _{ibo} | - | 40 | 50 | pF |

MAXIMUM RATINGS

| MAXIMOM DATINGS | | | | | |
|--|----------------------|-------------|---------|-------------------------|----------------|
| Rating | Symbol | MPQ7051 | MPQ7052 | MPQ7053 | Unit |
| Collector-Emitter Voltage | VCEO | 150 | 200 | 250 | Vdc |
| Collector-Base Voltage | V _{CBO} | 150 | 200 | 250 | Vdc |
| Emitter-Base Voltage | VEBO | | 5.0 | | Vdc |
| Collector Current — Continuous | lc | | 500 | | mAdc |
| | | Each Die | l E | ur Die Equal ower | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 750 5.98 | 1 | 1700 13.6 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.25 10 | | 3.2 25.6 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | Tj, T _{stg} | -55 to +150 | | °C | |

THERMAL CHARACTERISTICS

| Charac | teristic | Junction to Case | Junction to Ambient | Unit |
|--------------------|------------------|---------------------|------------------------|------|
| Thermal Resistance | Each Die | 100 | 167 | .cw |
| | Effective, 4 Die | 39 | 73.5 | .cw |
| Coupling Factors | Q1-Q4 or Q2-Q3 | 46 | 56 | % |
| | Q1-Q2 or Q3-Q4 | 5.0 | 10 | % |

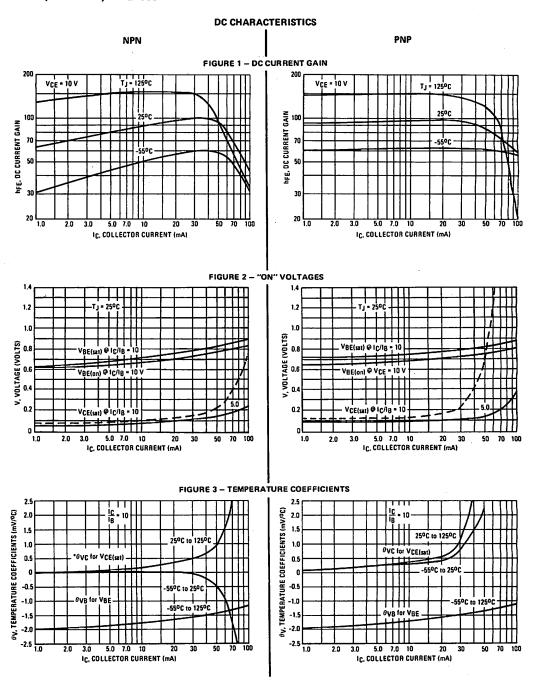
MPQ7051 MPQ7052 MPQ7053

CASE 646-05, TYPE 2 TO-116

QUAD COMPLIMENTARY PAIR TRANSISTOR

NPN/PNP SILICON

| Characteristic | | Symbol | Min | Max | Unit |
|---|-------------------------------|----------------------|-------------------|-------------------|------|
| OFF CHARACTERISTICS | | *** | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, IB = 0) | MPQ7051 MPQ7052 MPQ7053 | V(BR)CEO | 150 200 250 | = | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μ Adc, IE = 0) | MPQ7051 MPQ7052 MPQ7053 | V(BR)CBO | 150 200 250 | _ _ _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 5.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 120 Vdc, IE = 0) (VCB = 150 Vdc, IE = 0) (VCB = 180 Vdc, IE = 0) | MPQ7051 MPQ7052 MPQ7053 | ІСВО | = | 250 250 250 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, I _C = 0) | | IEBO | _ ` | 100 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc) (I _C = 30 mAdc, V _{CE} = 10 Vdc) | | hFE | 25 35 25 | = | _ |
| Collector-Emitter Saturation Voltage (IC = 20 mAdc, | lg = 2.0 mAdc) | V _{CE(sat)} | _ | 0.7 | Vdc |
| Base-Emitter Saturation Voltage (IC = 20 mAdc, IB = | 2.0 mAdc) | V _{BE(sat)} | _ | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, VCE = 20 Vdc, f = 100 MHz) | | fΤ | 50 | _ | MHz |
| Output Capacitance (V _{CB} = 20 Vdc, I _C = 0, f = 1.0 MHz) | | C _{obo} | _ | 6.0 | pF |
| Input Capacitance (VEB = 3.0 Vdc, I _C = 0, f = 1.0 MHz) | NPN PNP | C _{ibo} | = | 50 75 | pF |



MAXIMUM RATINGS

| Rating | Symbol | MPQ7091 | MPQ7092 | MPQ7093 | Unit |
|--|----------------------|----------------------------------|---------|--------------|----------------|
| Collector-Emitter Voltage | VCEO | 150 | 200 | 250 | Vdc |
| Collector-Base Voltage | V _{CBO} | 150 | 200 | 250 | Vdc |
| Emitter-Base Voltage | VEBO | | 5.0 | | Vdc |
| Collector Current — Continuous | lc | | 500 | | |
| | | Each Four Die Die Equal Power | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 750 5.98 | | 1700 13.6 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.25 10 | | 3.2 25.6 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | Tj, T _{stg} | -55 to +150 | | | °C |

THERMAL CHARACTERISTICS

| Charac | teristic | Junction to Case | Junction to Ambient | Unit |
|--------------------|----------------------------------|---------------------|------------------------|--------|
| Thermal Resistance | Each Die Effective, 4 Die | 100 39 | 167 73.5 | °C/W |
| Coupling Factors | Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4 | 46 5.0 | 56 10 | % % |

MPQ7091 MPQ7092 MPQ7093

CASE 646-05, STYLE 1 TO-116

QUAD AMPLIFIER TRANSISTOR

PNP SILICON

Refer to MPQ7051 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|-------------------------------|----------------------|-------------------|----------------|-------------------|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, IB = 0) | MPQ7091 MPQ7092 MPQ7093 | V(BR)CEO | 150 200 250 | - | - | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0) | MPQ7091 MPQ7092 MPQ7093 | V(BR)CBO | 150 200 250 | _ _ _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 μAdc, IC = 0) | | V(BR)EBO | 5.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 120 Vdc, IE = 0) (VCB = 150 Vdc, IE = 0) (VCB = 180 Vdc, IE = 0) | MPQ7091 MPQ7092 MPQ7093 | ІСВО | = | = | 250 250 250 | nAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, I _C = 0) | | EBO | _ | | 100 | nAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 10 Vdc) (I _C = 10 mAdc, V _{CE} = 10 Vdc) (I _C = 30 mAdc, V _{CE} = 10 Vdc) | | hFE | 25 35 25 | 40 55 50 | = | _ |
| Collector-Emitter Saturation Voltage (IC = 20 mAd | c, IB = 2.0 mAdc) | V _{CE(sat)} | | 0.3 | 0.5 | Vdc |
| Base-Emitter Saturation Voltage (IC = 20 mAdc, IB | = 2.0 mAdc) | V _{BE(sat)} | _ | 0.7 | 0.9 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product (IC = 10 mAdc, V _{CE} = 20 Vdc, f = 100 MHz) | | fΤ | 50 | 70 | _ | MHz |
| Output Capacitance (VCB = 20 Vdc, I _E = 0, f = 1.0 MHz) | | C _{obo} | _ | 3.0 | 5.0 | pF |
| Input Capacitance (VEB = 3.0 Vdc, I _C = 0, f = 1.0 MHz) | | Cibo | _ | 60 | 75 | pF |

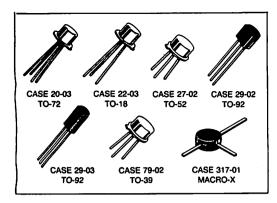
MQ982

For Specifications, See MD982 Data.

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The data sheets on the following pages are designed to emphasize those FET's that by virtue of widespread industry use, ease of manufacture, and consequently low relative cost, merit first consideration for new equipment design. Package options from low-cost plastic to metal packages are available.

CAUTION:

Static electricity is a surface phenomenon which most commonly occurs when two dissimilar materials come into contact and then separate. Electro Static Discharge (ESD) damage of semiconductor components by operating personnel is quickly becoming a very prominent and significant problem. From simple bipolar designs to sensitive MOSFET structures, ESD has its unforgiving effect of degradation or destruction.

Motorola believes it is important to extend an emphasizing note of cautiousness when handling and testing ANY FET product. Precautions include, but are not limited to, the implementation of static safe workstations and proper handling techniques (see below). Additionally, it is very important to keep FET devices in their antistatic shipping containers and away from any static-generating materials.

HANDLING CONSIDERATIONS:

MOS Field-Effect Transistors, due to their extremely high input resistance, are subject to potential damage by the accumulation of excess static charge. To avoid possible damage to the devices while handling, testing, or in actual operation, the following procedure should be followed:

- The leads of the devices should remain wrapped in the shorting spring except when being tested or in actual operation to avoid the build-up of static charge.
- Avoid unnecessary handling; when handled, the devices should be picked up by the can instead of the leads.
- The devices should not be inserted or removed from circuits with the power on as transient voltages may cause permanent damage to the devices.

Field-Effect Transistors

2N2608 2N2609

CASE 22-03, STYLE 12 TO-18 (TO-206AA)

JFET GENERAL PURPOSE

P-CHANNEL — DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|---------------|-------------|
| Drain-Source Voltage | VDS | 30 | Vdc |
| Drain-Gate Voltage | V _{DG} | 30 | Vdc |
| Gate-Source Voltage | VGS | 30 | Vdc |
| Gate Current | IG | 50 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 2.0 | mW mW/°C |
| Storage Temperature Range | T _{stq} | -60 to +200°C | °C |

Refer to 2N5460 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|------------------|------------------|--------------|---------------|-------|
| OFF CHARACTERISTICS | | | | | - |
| Gate-Source Breakdown Voltage (I _G = 1.0 μA) | | V(BR)GSS | 30 | | Vdc |
| Gate Reverse Current (VGS = 5.0 V) | | l _{GSS} | _ | 10 | nA |
| Gate Source Cutoff Voltage (V _{DS} = -5.0 V, I _D = -1.0 μA) | | VGS(off) | 1.0 | 4.0 | Vdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current (VDS = -5.0 V, VGS = 0 V) | 2N2608 2N2609 | IDSS* | -0.9 -2.0 | -4.5 -10.0 | mA |
| SMALL-SIGNAL CHARACTERISTICS | | ÷ | | | |
| Forward Transfer Admittance (VDS = -5.0 V, f = 1.0 kHz) | 2N2608 2N2609 | Yfs * | 1000 2500 | _ | μmhos |
| Input Capacitance (VDS = -5.0 V, VGS = 1.0 V, f = 140 kHz) | 2N2608 2N2609 | C _{iss} | - | 17 30 | pF |
| FUNCTIONAL CHARACTERISTICS | <u> </u> | · | • | | |
| Noise Figure (V _{DS} = -5.0 V, f = 1.0 kHz, R = 1.0 meg) | | NF | - | 3.0 | dB |

^{*}Pulse Width ≤ 100 msec., Duty Cycle ≤ 10%.

2N2843 2N2844

CASE 22-03, STYLE 22 TO-18 (TO-206AA)

JFET GENERAL PURPOSE

P-CHANNEL - DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|---------------|-------------|
| Drain-Source Voltage | VDS | . 30 | Vdc |
| Drain-Gate Voltage | VDG | 30 | Vdc |
| Gate-Source Voltage | VGS | 30 | Vdc |
| Drain Current | l _D | 50 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 2.0 | mW mW/°C |
| Storage Temperature Range | T _{sta} | -60 to +200°C | °C |

| Characteristic | | Symbol | Min | Max | Unit |
|--|------------------|----------------------|-------------|--------------|-------|
| OFF CHARACTERISTICS | | | | | • |
| Gate-Source Breakdown Voltage (IG = 1.0 μA) | | V(BR)GSS | 30 | _ | Vdc |
| Gate Reverse Current (VGS = 5.0 V) | | ^I GSS | _ | 10 | nA |
| Gate Source Cutoff Voltage (Vps = -5.0 V, lp = -1.0 μA) | | V _{GS(off)} | | 1.7 | Vdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current (V _{DS} = -5.0 V) | 2N2843 2N2844 | loss* | 200 440 | 1000 2200 | μΑ |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transfer Admittance (V _{DS} = -5.0 V, f = 1.0 kHz) | 2N2843 2N2844 | lYfsl* | 540 1400 | = | μmhos |
| Input Capacitance (VDS = -5.0 V, VGS = 1.0 V, f = 140 kHz) | 2N2843 2N2844 | C _{iss} | _ | 17 30 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | | |
| Noise Figure (Vps = -5.0 V, f = 1.0 kHz, R _G = 1.0 meg) | | NF | _ | 3.0 | dB |

^{*}Pulse Width ≤ 630 ms, Duty Cycle = 10%.

2N3330

CASE 20-03, STYLE 5 TO-72 (TO-206AF)

JFET AMPLIFIER

P-CHANNEL — DEPLETION

MAXIMUM RATINGS

| THE CONTROL OF THE CO | | | |
|--|------------------|-------------|---------------|
| Rating | Symbol | Value | Unit |
| Drain-Gate Voltage | VDG | 20 | Vdc |
| Reverse Gate-Source Voltage | VGSR | 20 | Vdc |
| Gate Current | IG | 10 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.3 2.0 | Watts mW/℃ |
| Storage Temperature Range | T _{sta} | -65 to +200 | °C |

Refer to 2N5460 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|----------|--------------|-----------|--------------|
| OFF CHARACTERISTICS | | | | |
| Gate-Source Breakdown Voltage (I _G = 10 µAdc, V _{DS} = 0) | V(BR)GSS | 20 | _ | Vdc |
| Gate Reverse Current (VGS = 10 Vdc, VDS = 0) (VGS = 10 Vdc, VDS = 0, TA = 150°C) | IGSS | _=_ | 10 10 | nAdc μAdc |
| ON CHARACTERISTICS | | | | |
| Zero-Gate-Voltage Drain Current(1) (VDS = -10 Vdc, VGS = 0) | IDSS | 2.0 | 6.0 | mAdc |
| Gate-Source Voltage (VpG = -15 Vdc, tp = 10 μAdc) | VGS | - | 6.0 | Vdc |
| Drain-Source Resistance (ID = 100 µAdc, VGS = 0) | rds | _ | 800 | Ohms |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Forward Transfer Admittance(1) (VDS = -10 Vdc, ID = 2.0 mAdc, f = 1.0 kHz) (VDS = -10 Vdc, ID = 2.0 mAdc, f = 10 MHz) | Yfs | 1500 1350 | 3000 — | μmhos |
| Output Admittence (Vps := -10 Vdc, lp = 2.0 mAdc, f = 1.0 kHz) | lyosl | 1 | 40 | μmhos |
| Reverse Transfer Conductance (VDS = -10 Vdc, ID = 2.0 mAdc, f = 1.0 kHz) | Yrs | - | 0.1 | μmhos |
| Input Conductance {V _{DS} = -10 Vdc, I _D = 2.0 mAdc, f = 1.0 kHz} | lyisl | | 0.2 | μmhos |
| Input Capacitance (Vps = -10 Vdc, Vgs = 1.0 Vdc, f = 1.0 MHz) | Ciss | - | 20 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | |
| Noise Figure (VDS = -5.0 Vdc, $t_D = 1.0$ mAdc, $R_G = 1.0$ Megohm, $f = 1.0$ kHz) | NF | _ | 3.0 | dB |

⁽¹⁾ Pulse Test: Pulse Width ≤ 630 ms, Duty Cycle ≤ 10%.

2N3331

CASE 20-03, STYLE 5 TO-72 (TO-206AF)

JFET LOW-FREQUENCY

P-CHANNEL -- DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|-------------|
| Drain-Source Voltage | VDS | 20 | Vdc |
| Drain-Gate Voltage | VDG | 20 | Vdc |
| Gate-Source Voltage | VGS | 20 | Vdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 2.0 | mW mW/°C |
| Storage Temperature Range | T _{stg} | -65 to +200 | °c |

Refer to 2N5460 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|------------------|-------|--------|-------|
| OFF CHARACTERISTICS | | | | |
| Gate-Source Breakdown Voltage (IG = 10 μA) | V(BR)GSS | 20 | | Vdc |
| Gate Reverse Current (VGS = 10 V, VDS = 0) | IGSS | - | 10 | nA |
| Gate Source Cutoff Voltage (V _{DS} = -15 V, I _D = -10 μA) | VGS(off) | _ | 8.0 | Vdc |
| ON CHARACTERISTICS | | | | |
| Zero-Gate-Voltage Drain Current (VDS = -10 V, VGS = 0 V) | loss* | - 5.0 | - 15.0 | mA |
| Drain-Source Resistance (I _D = -100 μA, V _{GS} = 0) | rDS | _ | 800 | ohms |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Forward Transfer Admittance (VDS = -10 V, ID = -5.0 mA, f = 1.0 kHz) | lyfsl* | 2000 | 4000 | μmhos |
| Output Admittance (Vps = -10 V, lp = -2.0 mA, f = 1.0 kHz) | lyosl* | _ | 100 | μmhos |
| Forward Transfer Admittance (V _{DS} = -10 V, I _D = -2.0 mA, f = 10 MHz) | Yfs* | 1350 | _ | μmhos |
| Input Capacitance (V _{DS} = -10 V, V _{GS} = 1.0 V, f = 1.0 MHz) | C _{iss} | - | 20 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | |
| Noise Figure (V _{DS} = -5.0 V, I _D = -1.0 mA, R _G = 1.0 M Ω , f = 1.0 kHz) | NF | _ | 4.0 | dB |

^{*}Pulse Width ≤ 300 µs, Duty Cycle ≤ 10%.

2N3436 2N3437 2N3438

CASE 22-03, STYLE 4 TO-18 (TO-206AA)

JFET LOW-FREQUENCY

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

| *************************************** | | | |
|---|------------------|-------------|-------|
| Rating | Symbol | Value | Unit |
| Drain-Gate Voltage | VDG | 50 | Vdc |
| Gate-Source Voltage | VGS | 50 | . Vdc |
| Gate Current | IG | 10 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 1.7 | mW/°C |
| Storage Temperature Range | T _{sta} | -65 to +175 | င္ |

| Characteristic | | Symbol | Min | Max | Unit |
|--|----------------------------|------------------|---------------------|-----------------------|-------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (I _G = 1.0 μA) | | V(BR)GSS | 50 | _ | Vdc |
| Gate Reverse Current (VGS = -30 V) | | ¹ GSS | _ | 0.5 | nA |
| Gate Source Cutoff Voltage (VDS = 20 V, ID = 1.0 nA) | 2N3436 2N3437 2N3438 | VGS(off) | = | 10.0 5.0 2.5 | Vdc |
| Gate Source Voltage (V _{DS} = 20 V, I _D = 1.0 μA) | 2N3436 2N3437 2N3438 | Vgs | = | 9.8 4.8 2.3 | Vdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current (VDS = 20 V) | 2N3436 2N3437 2N3438 | DSS* | 3.0 0.8 0.2 | 15 4.0 1.0 | mA |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transfer Admittance (VDS = 20 V, f = 1.0 kHz) | 2N3436 2N3437 2N3438 | lYfsl | 2500 1500 800 | 10000 6000 4500 | μmhos |
| Output Admittance (VDS = 30 V, f = 1.0 kHz) | 2N3436 2N3437 2N3438 | lyosl | Ξ | 35 20 5 | μmhos |
| Input Capacitance (V _{DS} = 10 V) (V _{DS} = 6.0 V) (V _{DS} = 4.0 V, f = 1.0 MHz) | 2N3436 2N3437 2N3438 | C _{iss} | _ | 18 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | | |
| Noise Figure (V _{DS} = 10 V, R _G = 1.0 m Ω , f = 1.0 kHz) | | NF | - | 2.0 | dB |

^{*}Pulse Width ≤ 630 msec, Duty Cycle ≤ 10%.

2N3458 2N3459 2N3460

CASE 22-03, STYLE 4 TO-18 (TO-206AA)

JFET LOW-FREQUENCY/ LOW NOISE

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|------------------|-------------|------------|
| Drain-Gate Voltage | VDG | 50 | Vdc |
| Gate-Source Voltage | VGS | 50 | Vdc |
| Gate Current | IG | 10 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 1.7 | mW mW/℃ |
| Storage Temperature Range | T _{sta} | -65 to +175 | ů |

| Characteristic | | Symbol | Min | Max | Unit |
|---|----------------------------|------------------|---------------------|-----------------------|-------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (I _G = 1.0 μA) | | V(BR)GSS | -50 | | Vdc |
| Gate Reverse Current (VGS = -30 V) | | IGSS | _ | 25 | nA |
| Gate Source Cutoff Voltage (V _{DS} = 20, I _D = 1.0 μA) | 2N3458 2N3459 2N3460 | VGS(off) | = | -7.8 -3.4 -1.8 | Vdc |
| ON CHARACTERISTICS | | | | | A |
| Zero-Gate-Voltage Drain (VDS = 20 Volts) | 2N3458 2N3459 2N3460 | loss* | 3.0 0.8 0.2 | 15.0 4.0 1.0 | mA |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transfer Admittance (VDS = 20 Volts, f = 1.0 kHz) | 2N3458 2N3459 2N3460 | lyfsi* | 2500 1500 800 | 10000 6000 4500 | μmhos |
| Output Admittance (VDS = 30 Volts, f = 1.0 kHz) | 2N3458 2N3459 2N3460 | lyosl | | 35 20 5 | μmhos |
| Input Capacitance (Vps = 10 V) | | C _{iss} | ı | 18 | pF |
| Output Capacitance (Vps = 30 V) | | Coss | 1 | 5.0 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | | |
| Noise Figure (VDS = 10 V, f = 20 Hz, RG = 1.0 M Ω) | 2N3458 2N3459 2N3460 | NF | = | 6.0 4.0 4.0 | dB |

^{*}Pulse Width ≤ 100 msec, Duty Cycle ≤ 10%.

2N3796 2N3797

CASE 22-03, STYLE 2 TO-18 (TO-206AA)

MOSFET LOW-POWER AUDIO

N-CHANNEL — DEPLETION

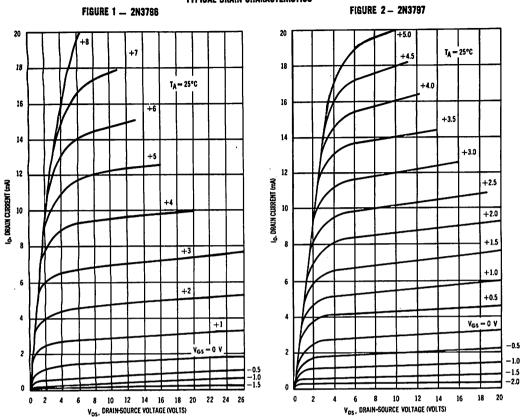
MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|-------------|
| Drain-Source Voltage 2N3796 2N3797 | V _{DS} | 25 20 | Vdc |
| Gate-Source Voltage | VGS | . ± 10 | Vdc |
| Drain Current | . I _D | 20 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 200 1.14 | mW mW/°C |
| Junction Temperature Range | TJ | + 175 | တ |
| Storage Channel Temperature Range | T _{stq} | -65 to +175 | ပ္ |

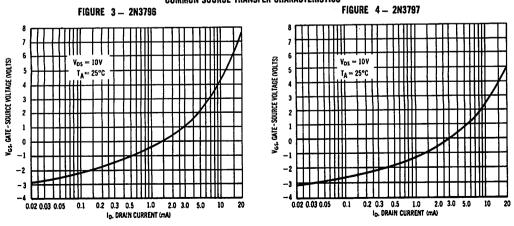
| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|------------------|--------------------|-------------|--------------|--------------|-------|
| OFF CHARACTERISTICS | | | | | | |
| Drain-Source Breakdown Voltage (VGS = -4.0 V, I _D = 5.0 μ A) (VGS = -7.0 V, I _D = 5.0 μ A) | 2N3796 2N3797 | V(BR)DSX | 25 20 | 30 25 | _ | Vdc |
| Gate Reverse Current(1) (VGS = -10 V, V _{DS} = 0) (VGS = -10 V, V _{DS} = 0, T _A = 150°C) | | IGSS | | _ | 1.0 200 | pAdc |
| Gate Source Cutoff Voltage $\{I_D = 0.5 \mu A, V_{DS} = 10 V\}$ $\{I_D = 2.0 \mu A, V_{DS} = 10 V\}$ | 2N3796 2N3797 | VGS(off) | = | -3.0 -5.0 | -4.0 -7.0 | Vdc |
| Drain-Gate Reverse Current(1) (Vpg = 10 V, ls = 0) | | IDGO | _ | - | 1.0 | pAdc |
| ON CHARACTERISTICS | | | | | | _ |
| Zero-Gate-Voltage Drain Current (VDS = 10 V, VGS = 0) | 2N3796 2N3797 | IDSS | 0.5 2.0 | 1.5 2.9 | 3.0 6.0 | mAdc |
| On-State Drain Current (VDS = 10 V, VGS = +3.5 V) | 2N3796 2N3797 | l _{D(on)} | 7.0 9.0 | 8.3 14 | 14 18 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Forward Transfer Admittance (VDS = 10 V, VGS = 0, f = 1.0 kHz) | 2N3796 2N3797 | lyfsl | 900 1500 | 1200 2300 | 1800 3000 | μmhos |
| (V _{DS} = 10 V, V _{GS} = 0, f = 1.0 MHz) | 2N3796 2N3797 | | 900 1500 | _ | = | } |
| Output Admittance (Vps = 10 V, Vgs = 0, f = 1.0 kHz) | 2N3796 2N3797 | lyosl | = | 12 27 | 25 60 | μmhos |
| Input Capacitance (VDS = 10 V, VGS = 0, f = 1.0 MHz) | 2N3796 2N3797 | C _{iss} | _ | 5.0 6.0 | 7.0 8.0 | pF |
| Reverse Transfer Capacitance {Vps = 10 V, Vgs = 0, f = 1.0 MHz} | | C _{rss} | _ | 0.5 | 0.8 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | | | |
| Noise Figure (VDS = 10 V, VGS = 0, f = 1.0 kHz, R _S = 3 megohms) | | NF | _ | 3.8 | _ | ďΒ |

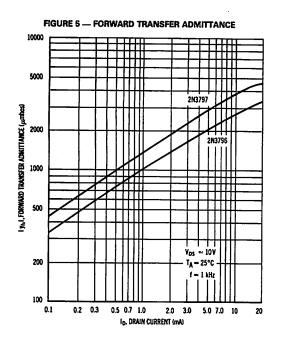
⁽¹⁾ This value of current includes both the FET leakage current as well as the leakage current associated with the test socket and fixture when measured under best attainable conditions.

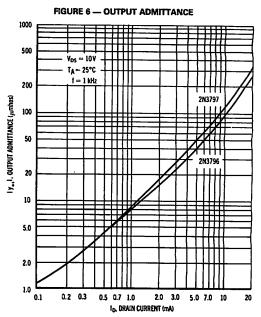
TYPICAL DRAIN CHARACTERISTICS

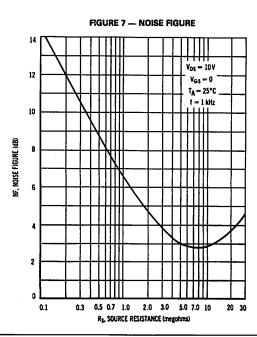


COMMON SOURCE TRANSFER CHARACTERISTICS









2N3821 2N3822 2N3824

CASE 20-03, STYLE 1 TO-72 (TO-206AF)

JFET LOW FREQUENCY, LOW NOISE

N-CHANNEL — DEPLETION JAN 2N3821 AND JAN 2N3822 AVAILABLE

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|-------------|
| Drain-Source Voltage | V _{DS} | 50 | Vdc |
| Drain-Gate Voltage | VDG | 50 | Vdc |
| Gate-Source Voltage | VGS | -50 | Vdc |
| Drain Current | l _D | 10 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 2.0 | mW mW/°C |
| Junction Temperature Range | TJ | 175 | °C |
| Storage Temperature Range | T _{stg} | -65 to +200 | °C |

Refer to 2N4220 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|------------------|---------------------|----------------|----------------|-------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (IG = -1.0 μAdc, VDS = 0) | | V(BR)GSS | - 50 | _ | Vdc |
| Gate Reverse Current {VGS = -30 Vdc, V _{DS} = 0} {VGS = -30 Vdc, V _{DS} = 0, T _A = 150°C} | | IGSS | = | - 0.1 - 100 | nAdc |
| Gate Source Cutoff Voltage (Ip = 0.5 nAdc, Vps = 15 Vdc) | 2N3821 2N3822 | VGS(off) | | -4.0 -6.0 | Vdc |
| Gate Source Voltage (I _D = 50 µAdc, V _{DS} = 15 Vdc) (I _D = 200 µAdc, V _{DS} = 15 Vdc) | 2N3821 2N3822 | VGS | - 0.5 - 1.0 | - 2.0 - 4.0 | Vdc |
| Drain Cutoff Current (VDS = 15 Vdc, VGS = -8.0 Vdc) (VDS = 15 Vdc, VGS = -8.0 Vdc, T _A = 150°C) | 2N3824 2N3824 | ^I D(off) | | 0.1 100 | nAdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current(1) (VDS = 15 Vdc, VGS = 0) | 2N3821 2N3822 | IDSS | 0.5 2.0 | 2.5 10 | mAdc |
| Static Drain-Source On Resistance (VGS = 0, ID = 0, f = 1.0 kHz) | 2N3824 | ^r DS(on) | _ | 250 | Ohms |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transfer Admittance (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz)(1) | 2N3821 2N3822 | lyfsl | 1500 3000 | 4500 6500 | μmhos |
| (VDS = 15 Vdc, VGS = 0, f = 100 MHz) | 2N3821 2N3822 | | 1500 3000 | _ | |
| Output Admittance(1) (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz) | 2N3821 2N3822 | lyosl | _ | 10 20 | μmhos |
| Input Capacitance (VDS = 15 Vdc, VGS = 0, f = 1.0 MHz) | | C _{iss} | _ | 6.0 | pF |
| Reverse Transfer Capacitance (Vps = 15 Vdc, Vgs = 0, f = 1.0 MHz) | 2N3821 2N3822 | C _{rss} | = | 3.0 3.0 | pF |
| $(V_{GS} = -8.0 \text{ Vdc}, V_{DS} = 0, f = 1.0 \text{ MHz})$ | 2N3824 | | _ | 3.0 | |

2N3821, 2N3822, 2N3824

| Characteristic | *************************************** | Symbol | Min | Max | Unit |
|--|---|----------------|-----|-----|----------------------|
| FUNCTIONAL CHARACTERISTICS | | <u> </u> | | | |
| Noise Figure (V _{DS} = 15 Vdc, V _{GS} = 0, R _S = 1.0 megohm, f = 10 Hz, Noise Bandwidth = 5.0 Hz) | 2N3821, 2N3822 | NF | _ | 5.0 | dB |
| Equivalent Input Noise Voltage (VDS = 15 Vdc, VGS = 0, f = 10 Hz, Noise Bandwidth = 5.0 Hz) | 2N3821, 2N3822 | e _n | _ | 200 | nv/Hz ^{1/2} |

⁽¹⁾ Pulse Test: Pulse Width ≤ 100 ms, Duty Cycle ≤ 10%.

2N3823

JAN, JANTX AVAILABLE **CASE 20-03, STYLE 1** TO-72 (TO-206AF)

JFET VHF AMPLIFIER

N-CHANNEL - DEPLETION

MAXIMUM RATINGS Rating **Symbol** Value Unit **Drain-Source Voltage** VDS 30 Vdc Vdc **Drain-Gate Voltage** VDG 30 Gate-Source Voltage -30 Vdc VGS 10 mAdc **Gate Current** IG Total Device Dissipation @ TA = 25°C P_{D} 300 mW Derate above 25°C mW/°C 2.0 **Junction Temperature Range** TJ 175 °C Storage Temperature Range Tstg -65 to +200

Refer to 2N4416 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|-------------------------------|--------------|----------------|-------|
| OFF CHARACTERISTICS | | | · . | |
| Gate-Source Breakdown Voltage (IG = -1.0 μAdc, Vps = 0) | V(BR)GSS | 30 | - | Vdc |
| Gate Reverse Current (VGS = -20 Vdc, VDS = 0) (VGS = -20 Vdc, VDS = 0, TA = 150°C) | IGSS | | - 0.5 - 500 | nAdc |
| Gate Source Cutoff Voltage (ID = 0.5 nAdc, VDS = 15 Vdc) | VGS(off) | _ | -8.0 | Vdc |
| Gate Source Voltage (ID = 0.4 mAdc, VDS = 15 Vdc) | V _{GS} | - 1.0 | -7.5 | Vdc |
| ON CHARACTERISTICS | • | | | |
| Zero-Gate-Voltage Drain Current(1) (Vps = 15 Vdc, Vgs = 0) | IDSS | 4.0 | 20 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Forward Transfer Admittance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 kHz)(1) (V _{DS} = 15 Vdc, V _{GS} = 0, f = 200 MHz) | Yfs | 3500 3200 | 6500 — | μmhos |
| Input Admittance (Vps = 15 Vdc, Vgs = 0, f = 200 MHz) | Re(y _{is}) | _ | 800 | μmhos |
| Output Conductance (Vps = 15 Vdc, Vgs = 0, f = 1.0 kHz)(1) (Vps = 15 Vdc, Vgs = 0, f = 200 MHz) | Yos Re(y _{OS}) | _ | 35 200 | μmhos |
| Input Capacitance (Vps = 15 Vdc, Vgs = 0, f = 1.0 MHz) | C _{iss} | - | 6.0 | pF |
| Reverse Transfer Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz) | C _{rss} | _ | 2.0 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | |
| Noise Figure (V _{DS} = 15 Vdc, V _{GS} = 0, R _S = 1000 ohms, f = 100 MHz) | NF | | 2.5 | dB |

⁽¹⁾ Pulse Test: Pulse Width = 100 ms, Duty Cycle ≤ 10%.

2N3909,A

CASE 20-03, STYLE 5 TO-72 (TO-206AF)

JFET AMPLIFIER

P-CHANNEL — DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|--------|-------------|------------|
| Drain-Source Voltage | VDS | -20 | Vdc |
| Drain-Gate Voltage | VDG | -20 | Vdc |
| Reverse Gate-Source Voltage | VGSR | 20 | Vdc |
| Forward Gate Current | IGF | 10 | mAdc |
| Forward Gate-Source Voltage | VGSF | 20 | Vdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 2.0 | mW mW/℃ |
| Storage Temperature Range | Tstg | -65 to +200 | °C |

Refer to 2N5460 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|-------------------|------------------|--------------|--------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (IG = 10 µAdc, VDS = 0) | | V(BR)GSS | 20 | 1 | Vdc |
| Gate Reverse Current (VGS = 10 Vdc, VDS = 0) (VGS = 10 Vdc, VDS = 0, TA = 100°C) | | IGSS | | 10 1.0 | nAdc µAdc |
| Gate Source Cutoff Voltage (V _{DS} = -10 Vdc, I _D = 10 μAdc) | 2N3909 2N3909A | VGS(off) | _ | 8.0 8.0 | Vdc |
| Gate Source Voltage (V _{DS} = -10 Vdc, I _D = 30 μAdc) | | VGS | 0.3 | 7.9 | Vdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current(2) (VDS = -10 Vdc, VGS = 0) | 2N3909 2N3909A | IDSS | 0.3 1.0 | 15 15 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transfer Admittance(2) (Vps = -10 Vdc, Vgs = 0, f = 1.0 kHz) | 2N3909 2N3909A | lyfsl | 1000 2200 | 5000 5000 | μmhos |
| $(V_{DS} = -10 \text{ Vdc}, V_{GS} = 0, f = 10 \text{ MHz})$ | 2N3909 2N3909A | | 900 2000 | _ | |
| Output Admittance (VDS = -10 Vdc, VGS = 0, f = 1.0 kHz) | | lyosl | - | 100 | μmhos |
| Input Capacitance (VDS = -10 Vdc, VGS = 0, f = 1.0 MHz) | 2N3909 2N3909A | C _{iss} | - | 32 9.0 | pF |
| Reverse Transfer Capacitance (VDS = -10 Vdc, VGS = 0, f = 1.0 MHz) | 2N3909 2N3909A | C _{rss} | = | 16 3.0 | pF |

⁽¹⁾ The fourth lead (case) is connected to the source for all measurements.

⁽²⁾ Pulse Test: Pulse Width ≤ 630 ms, Duty Cycle ≤ 10%.

2N3966

CASE 20-03, STYLE 1 TO-72 (TO-206AF)

JFET HIGH-FREQUENCY AMPLIFIER

N-CHANNEL - DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|-------------|
| Drain-Source Voltage | VDS | 30 | Vdc |
| Drain-Gate Voltage | VDG | 30 | Vdc |
| Gate-Source Voltage | VGS | 30 | Vdc |
| Gate Current | IG | 10 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C (Free Air) | PD | 300 1.71 | mW mW/°C |
| Lead Temperature (1/16" from Case for 10 Seconds) | TL | 300 | ů |
| Storage Temperature Range | T _{stq} | -55 to 200 | °C |

| Characteristic | Symbol | Min | Max | Unit |
|--|---------------------|-----|------------|----------|
| OFF CHARACTERISTICS | | | | |
| Gate-Source Breakdown Voltage (I _G = 1.0 µA, V _{DS} = 0) | V(BR)GSS | -30 | _ | Vdc |
| Gate Reverse Current (VGS = 20 V, VDS = 0) | lgss | _ | 0.1 | nA |
| Drain Cutoff Current (VDS = 10 V, VGS = -7.0 V, TA = 150°C) | D(off) | _ | 2.0 | μΑ |
| Gate Source Cutoff Voltage (I _D = 10 nA, V _{DS} = 10 V) | VGS(off) | 4.0 | 6.0 | Vdc |
| ON CHARACTERISTICS | | - | | |
| Zero-Gate-Voltage Drain Current (VDS = 20 V, VGS = 0) | IDSS | 2.0 | _ | mA |
| Drein-Source "ON" Voltage (I _D = 1.0 mA, V _{GS} = 0 V) | V _{DS(on)} | _ | 0.25 | Vdc |
| Drain Reverse Current (V _{DG} = 20 V, I _S = 0 A) (25 (15 | °C) | = | 0.1 0.2 | nA μΑ |
| Static Drain-Source On Resistance (VGS = 0 V, ID = 0, f = 1.0 kHz) | rDS(on) | _ | 220 | Ω |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Input Capacitance (Vps = 20 V, Vgs = 0 V, f = 1.0 MHz) | C _{iss} | _ | 6.0 | pF |
| Reverse Transfer Capacitance (Vps = 0 V, Vgs = 7.0 V, f = 1.0 MHz) | C _{rss} | | 1.5 | pF |
| SWITCHING CHARACTERISTICS | | | | |
| Delay Time (See Figure 1) | td | _ | 0.02 | μѕес |
| Rise Time (See Figure 1) | t _r | _ | 100 | nsec |
| Turn-Off Time (See Figure 1) | t _{off} | _ | 100 | nsec |

2N3970 2N3971 2N3972

CASE 22-03, STYLE 4 TO-18 (TO-206AA)

JFET SWITCHING

N-CHANNEL - DEPLETION

MAXIMUM RATINGS

| MAXIMUM RATINGS | | | |
|---|------------------|-------------|----------------|
| Rating | Symbol - | Value | Unit |
| Drain-Source Voltage | VDS | 40 | Vdc |
| Drain-Gate Voltage | VDG | 40 | Vdc |
| Reverse Gate-Source Voltage | VGSR | 40 | Vdc |
| Forward Gate Current | lGF | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.8 10 | Watts mW/°C |
| Storage Temperature Range | T _{stg} | -65 to +200 | °C |

Symbol

Min

| ELECTRICAL CHARACTERISTICS | (IA = 25°C unless otherwise noted.) |
|----------------------------|-------------------------------------|
| C | Characteristic |

| | Characteristic | | Symbol | ****** | IVIGA | Oille |
|---------------------------|--|----------------------------|---------------------|-------------------|-------------------|--------------|
| OFF CHARACTERISTICS | | | | | | |
| Gate-Source Breakdown \ | /oltage (I _G = 1.0 μAdc, V _{GS} = 0) | | V(BR)GSS | 40 | - | Vdc |
| Gate Reverse Current (V | GS = 20 Vdc, V _{DS} = 0) | | lgss | _ | 250 | pAdc |
| Drain Reverse Current (\ | /DG = 20 Vdc, IS = 0) /DG = 20 Vdc, IS = 0, T _A = 150°C) | | IDGO | _ | 250 500 | pAdc nAdc |
| | S = 20 Vdc, VGS = -12 Vdc) S = 20 Vdc, VGS = -12 Vdc, TA = 150°C) | | ^I D(off) | | 250 500 | pAdc nAdc |
| Gate Source Voltage (V | OS = 20 Vdc, ID = 1.0 nAdc) | 2N3970 2N3971 2N3972 | V _{GS} | 4.0 2.0 0.5 | 10 5.0 3.0 | Vdc |
| ON CHARACTERISTICS | | | | | | |
| Zero-Gate-Voltage Drain (| Current(1) (V _{DS} = 20 Vdc, V _{GS} = 0) | 2N3970 2N3971 2N3972 | IDSS | 50 25 5.0 | 150 75 30 | mAdc |
| Drain-Source On-Voltage | (I _D = 20 mAdc, V _{GS} = 0) (I _D = 10 mAdc, V _{GS} = 0) (I _D = 5.0 mAdc, V _{GS} = 0) | 2N3970 2N3971 2N3972 | VDS(on) | <u>-</u> | 1.0 1.5 2.0 | Vdc |
| Static Drain-Source On Re | esistance (ID = 1.0 mAdc, VGS = 0) | 2N3970 2N3971 2N3972 | ^r DS(on) | | 30 60 100 | Ohms |
| SMALL-SIGNAL CHARAC | TERISTICS | | | | • | |
| Drain-Squrce "ON" Resis | tance $(V_{GS} = 0, I_D = 0, f = 1.0 \text{ kHz})$ | 2N3970 2N3971 2N3972 | ^r ds(on) | | 30 60 100 | Ohms |
| Input Capacitance (VDS | = 20 Vdc, VGS = 0, f = 1.0 MHz) | | Ciss | 1 | 25 | ρF |
| | ance (V _{DS} = 0, V _{GS} = -12 Vdc, f = 1.0 M | Hz) | Crss | | 6.0 | pF |
| SWITCHING CHARACTE | RISTICS | | | | | |
| Turn-On Delay Time | Test Condition for 2N3970: (VDD = 10 Vdc, VGS(on) = 0, ID(on) = 20 mAdc, VGS(off) = 10 Vdc) | 2N3970 2N3971 2N3972 | ^t d(on) | | 10 15 40 | ns |
| Rise Time | Test Condition for 2N3971: (VDD = 10 Vdc, VGS(on) = 0, ID(on) = 10 mAdc, VGS(on) = 5.0 Vdc) | 2N3970 2N3971 2N3972 | t _r | = | 10 15 40 | ns |
| Turn-Off Time | Test Condition for 2N3972: (VDD = 10 Vdc, VGS(on) = 0, ID(on) = 5.0 mAdc, VGS(off) = 3.0 Vdc) | 2N3970 2N3971 2N3972 | ^t off | = | 30 60 100 | ns |

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 3.0%.

2N3993,A 2N3994,A

CASE 20-03, STYLE 5 TO-72 (TO-206AF)

JFET SWITCHING

P-CHANNEL — DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|-------------|
| Drain-Source Voltage | VDS | - 25 | Vdc |
| Drain-Gate Voltage | VDG | -25 | Vdc |
| Reverse Gate-Source Voltage | VGSR | 25 | Vdc |
| Forward Gate Current | IGF | 10 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 2.0 | mW mW/°C |
| Storage Temperature Range | T _{stg} | -65 to +200 | °C |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|---|---|------------------|--------------------------|-------------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (I _G = 1.0 μAdc, V _{DS} = 0) | | V(BR)GSS | 25 | _ | Vdc |
| Drain Reverse Current $(V_{DG} = -15 \text{ Vdc}, I_S = 0)$ $(V_{DG} = -15 \text{ Vdc}, I_S = 0, T_A = 150^{\circ}\text{C})$ | | IDGO | _ | 1.2 1.2 | nAdc µAdc |
| Drain Cutoff Current (V _{DS} = -10 Vdc, V _{GS} = 10 Vdc) (V _{DS} = -10 Vdc, V _{GS} = 6.0 Vdc) (V _{DS} = -10 Vdc, V _{GS} = 10 Vdc, T _A = 150°) | 2N3993, 2N3993A 2N3994, 2N3994A 2N3993, 2N3993A | ID(off) | = | 1.2 1.2 1.0 | nAdc μAdc |
| (V _{DS} = -10 Vdc, V _{GS} = 6.0 Vdc, T _A = 150°) Gate Source Voltage (V _{DS} = -10 Vdc, I _D = -1.0 μAdc) | 2N3994, 2N3994A 2N3993, 2N3993A 2N3994, 2N3994A | V _{GS} | 4.0 1.0 | 9.5 5.5 | Vdc |
| ON CHARACTERISTICS | | | | | l |
| Zero-Gate-Voltage Drain Current(1) (VDS = -10 Vdc, VGS = 0) | 2N3993, 2N3993A 2N3994, 2N3994A | IDSS | 10 2.0 | _ | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | • | | | ' |
| Drain-Source "ON" Resistance (VGS = 0, ID = 0, f = 1.0 kHz) | 2N3993, 2N3993A 2N3994, 2N3994A | rds(on) | - | 150 300 | Ohms |
| Forward Transfer Admittance(1) (VDS = -10 Vdc, VGS = 0, f = 1.0 kHz) | 2N3993 2N3993A 2N3994 2N3994A | lYfsl | 6.0 7.0 4.0 5.0 | 12 12 10 | mmhos |
| Input Capacitance (VDS = -10 Vdc, VGS = 0, f = 1.0 MHz) | 2N3993, 2N3994 2N3993A, 2N3994A | C _{iss} | = | 16 12 | pF |
| Reverse Transfer Capacitance (V _{DS} = 0, V _{GS} = 10 Vdc, f = 1.0 MHz) | 2N3993 2N3993A | C _{rss} | = | 4.5 3.0 | pF |
| (V _{DS} = 0, V _{GS} = 6.0 Vdc, f = 1.0 MHz) | 2N3994 2N3994A | | _ | 5.0 3.5 | |

(1) Pulse Test: Pulse Width = 100 ms, Duty Cycle ≤ 10%.

2N4091 2N4092 2N4093

JAN, JTX AVAILABLE CASE 22-03, STYLE 3 TO-18 (TO-206AA)

JFET SWITCHING

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

| MAXIMOM NATINGS | | | |
|---|------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Drain-Source Voltage | V _{DS} | 40 | Vdc |
| Drain-Gate Voltage | VDG | 40 | Vdc |
| Gate-Source Voltage | VGS | 40 | Vdc |
| Gate Current | IG | 10 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.8 10 | Watts mW/°C |
| Junction Temperature Range | TJ | -65 to +175 | °C |
| Storage Temperature Range | T _{sta} | -65 to +175 | °C |

| Characteristic | | Symbol | Min | Max | Unit |
|---|--------------------------------------|---------------------|-------------------|-------------------|--------------|
| OFF CHARACTERISTICS | | | - | | |
| Gate-Source Breakdown Voltage (I _G = 1.0 μAdc, V _{DS} = 0) | | V(BR)GSS | 40 | _ | Vdc |
| Drain-Gate Breakdown Voltage (I _D = 1.0 µAdc, I _S = 0) | | V(BR)DGO | 40 | _ | Vdc |
| Gate Source Cutoff Voltage (VDS = 20 Vdc, ID = 1.0 nAdc) | 2N4091 2N4092 2N4093 | VGS(off) | 5.0 2.0 1.0 | 10 7.0 5.0 | Vdc |
| Source Reverse Current (VSG = 20 Vdc, ID = 0) | | Isgo | _ | 0.2 | nAdc |
| Drain Reverse Current (VDG = 20 Vdc, IS = 0) (VDG = 20 Vdc, ID = 0, TA = 150°C) | | l _D GO | = | 0.2 0.4 | nAdc µAdc |
| Drain-Cutoff Current (VDS = 20 Vdc, VGS = 12 Vdc) (VDS = 20 Vdc, VGS = 8.0 Vdc) | 2N4091 2N4092 2N4093 | ID(off) | = | 0.2 0.2 0.2 | nAdc |
| (V _{DS} = 20 Vdc, V _{GS} = 6.0 Vdc) (V _{DS} = 20 Vdc, V _{GS} = 12 Vdc, T _A = 150°C) (V _{DS} = 20 Vdc, V _{GS} = 8.0 Vdc, T _A = 150°C) (V _{DS} = 20 Vdc, V _{GS} = 6.0 Vdc, T _A = 150°C) | 2N4093 2N4091 2N4092 2N4093 | | 1111 | 0.4 0.4 0.4 | μAdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current* (VDS = 20 Vdc, VGS = 0) | 2N4091 2N4092 2N4093 | IDSS* | 30 15 8.0 | _ | mAdc |
| Drain-Source On-Voltage (Ip = 6.6 mAdc, VGS = 0) (Ip = 4.0 mAdc, VGS = 0) (Ip = 2.5 mAdc, VGS = 0) | 2N4091 2N4092 2N4093 | V _{DS(on)} | = | 0.2 0.2 0.2 | Vdc |
| Static Drain-Source On Resistance (Ip = 1.0 mAdc, Vgs = 0) | 2N4091 2N4092 2N4093 | rDS(on) | = | 30 50 80 | Ohms |

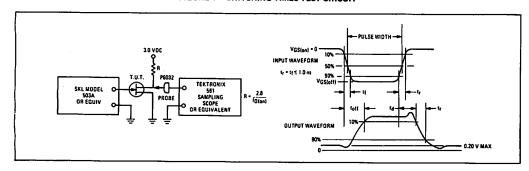
2N4091, 2N4092, 2N4093

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|--|----------------------------|---------------------|-----|----------------|-------------|
| SMALL-SIGNAL CHARACTERISTICS | | • | | | |
| Drain-Source "ON" Resistance (VGS = 0, ID = 0, f = 1.0 kHz) | 2N4091 2N4092 2N4093 | ^r ds(on) | - | 30 50 80 | Ohms |
| Input Capacitance (VDS = 20 Vdc, VGS = 0, f = 1.0 MHz) | | C _{iss} | | 16 | pF |
| Reverse Transfer Capacitance (Vps = 0, Vgs = 20 Vdc, f = 1.0 MHz) | | C _{rss} | | 5.0 | pF |
| SWITCHING CHARACTERISTICS | | | | | |
| Delay Time (See Figure 1) (ID(on) = 6.6 mAdc) (ID(on) = 4.0 mAdc) (ID(on) = 2.5 mAdc) | 2N4091 2N4092 2N4093 | ^t d | = | 15 15 20 | ns |
| Rise Time (See Figure 1) (ID(on) = 6.6 mAdc) (ID(on) = 4.0 mAdc) (ID(on) = 2.5 mAdc) | 2N4091 2N4092 2N4093 | t _r | = | 10 20 40 | ns |
| Turn-Off Time (See Figure 1) (VGS(off) = 12 Vdc) (VGS(off) = 8.0 Vdc) (VGS(off) = 6.0 Vdc) | 2N4091 2N4092 2N4093 | ^t off | = | 40 60 80 | ns |

^{*}Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 3.0%.

FIGURE 1 - SWITCHING TIMES TEST CIRCUIT



2N4117,A 2N4118,A 2N4119,A

CASE 20-03, STYLE 1 TO-72 (TO-206AF)

JFET AMPLIFIER

N-CHANNEL - DEPLETION

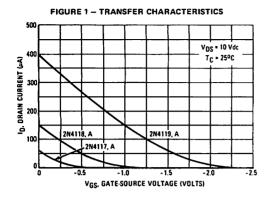
MAXIMUM RATINGS

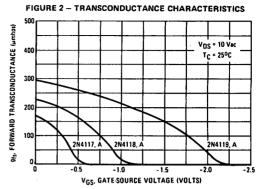
| Rating | Symbol | Value | Unit. | |
|--|------------------|-------------|-------------|--|
| Drain-Source Voltage | VDS | -40 | Vdc | |
| Drain-Gate Voltage | V _{DG} | -40 | Vdc | |
| Gate Current | IG | 50 | mAdc | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 2.0 | mW mW/°C | |
| Lead Temperature (1/16" from case for 10 s) | , TL | 255 | °C | |
| Storage Temperature Range | T _{stq} | -65 to +175 | °C | |

| Characterist | ic | Symbol | Min | Max | Unit |
|--|---|------------------|----------------------|-------------------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (IG = -1.0 μAdc, VDS = 0) | | V(BR)GSS | -40 | | Vdc |
| Gate Reverse Current (VGS = 20 Vdc, VDS = 0) | 2N4117,4118,4119 2N4117A,4118A,4119A | IGSS | = | -10 -1.0 | pAdc nAdc |
| (VGS = 20 Vdc, VDS = 0, TA = 150°C) | 2N4117,4118,4119 2N4117A,4118A,4119A | | | -2.5 | HAGE |
| Gate Source Cutoff Voltage (ID = 1.0 nAdc, VDS = 10 Vdc) | 2N4117,A 2N4118,A 2N4119,A | VGS(off) | -0.6 -1.0 -2.0 | - 1.8 - 3.0 - 6.0 | Vdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current(1) (VDS = 10 Vdc, VGS = 0) | 2N4117,A 2N4118,A 2N4119,A | IDSS | 0.03 0.08 0.20 | 0.09 0.24 0.60 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Input Capacitance (VDS = 10 Vdc, VGS = 0, f = 1.0 MHz) | | C _{iss} | _ | 3.0 | pF |
| Reverse Transfer Capacitance (VDS = 10 Vdc, VGS = 0, f = 1.0 MHz) | | C _{rss} | - | 1.5 | pF |
| Forward Transconductance (VDS = 10 Vdc, VGS = 0, f = 1.0 kHz) | 2N4117,A 2N4118,A 2N4119,A | 9fs | 70 80 100 | 210 250 330 | μmhos |
| Output Conductance (VDS = 10 Vdc, VGS = 0, f = 1.0 kHz) | 2N4117,A 2N4118,A 2N4119,A | 9os | - - - | 3.0 5.0 10 | μmhos |

⁽¹⁾ IDSS is measured during a 2.0-ms interval 100 ms after power is applied. (NOT a JEDEC condition.)

2N4117,A, 2N4118,A, 2N4119,A





2N4220 thru 2N4222

2N4220,A thru 2N4222,A

CASE 20-03, STYLE 3 TO-72 (TO-206AF)

JFET LOW-FREQUENCY, LOW NOISE

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

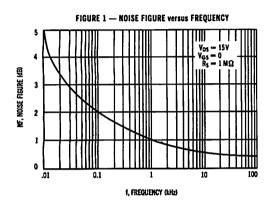
| Rating | Symbol | Value | Unit | |
|---|------------------|-------------|------------|--|
| Drain-Source Voltage | V _{DS} | 30 | Vdc | |
| Drain-Gate Voltage | VDG | 30 | Vdc | |
| Gate-Source Voltage | VGS | -30 | Vdc | |
| Drain Current | l _D | 15 | mAdc | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 2 | mW mW/℃ | |
| Junction Temperature Range | TJ | 175 | ° C | |
| Storage Channel Temperature Range | T _{stg} | -65 to +200 | က္ | |

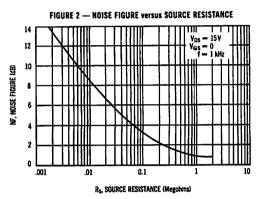
| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|----------------------------------|------------------|----------------------|-------------------|----------------------|-------|
| OFF CHARACTERISTICS | | | | | | |
| Gate-Source Breakdown Voltage (IG = -10 µAdc, VDS = 0) | | V(BR)GSS | -30 | - | - | Vdc |
| Gate Reverse Current (VGS = -15 Vdc, VDS = 0) (VGS = -15 Vdc, VDS = 0, TA = 150°C) | | IGSS | <u>-</u> | _ | -0.1 -100 | nAdc |
| Gate Source Cutoff Voltage (ID = 0.1 nAdc, V _{DS} = 15 Vdc) | 2N4220,A 2N4221,A 2N4222,A | VGS(off) | _ | _ | -4 -6 -8 | Vdc |
| Gate Source Voltage (I _D = 50 µAdc, V _{DS} = 15 Vdc) (I _D = 200 µAdc, V _{DS} = 15 Vdc) (I _D = 500 µAdc, V _{DS} = 15 Vdc) | 2N4220,A 2N4221,A 2N4222,A | V _G S | -0.5 -1.0 -2.0 | = | -2.5 -5.0 -6.0 | Vdc |
| ON CHARACTERISTICS | | | r | | | |
| Zero-Gate-Voltage Drain Current* (VDS = 15 Vdc, VGS = 0) | 2N4220,A 2N4221,A 2N4222,A | l _{DSS} | 0.5 2.0 5.0 | = | 3.0 6.0 15 | mAdc |
| Static Drain-Source On Resistance (VDS = 0, VGS = 0) | 2N4220,A 2N4221,A 2N4222,A | rDS(on) | = | 500 400 300 | _ | Ohms |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | _ |
| Forward Transfer Admittance Common Source* (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz) | 2N4220,A 2N4221,A 2N4222,A | Yfs | 1000 2000 2500 | _ | 4000 5000 6000 | μmhos |
| Output Admittance Common Source (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz) | 2N4220,A 2N4221,A 2N4222,A | lyosi | = | = | 10 20 40 | μmhos |
| Input Capacitance (Vps = 15 Vdc, Vgs = 0, f = 1.0 MHz) | | Ciss | | 4.5 | 6.0 | pF |
| Reverse Transfer Capacitance (VDS = 15 Vdc, VGS = 0, f = 1.0 MHz) | | C _{rss} | _ | 1.2 | 2.0 | pF |
| Common-Source Output Capacitance (VDS = 15 Vdc, VGS = 0, f = 30 MHz) | | C _{osp} | | 1.5 | <u> </u> | pF |

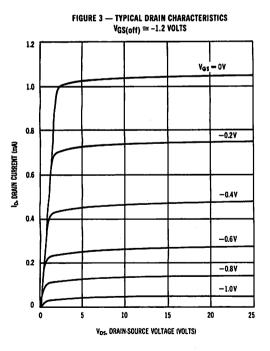
2N4220 thru 2N4222, 2N4220A thru 2N4222A

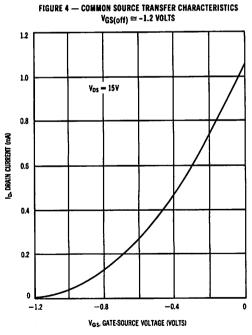
| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|-------------------------------|--------|-----|-----|-------------------|------|
| FUNCTIONAL CHARACTERISTICS | | | | | | |
| Noise Figure (VDS = 15 Vdc, VGS = 0, RS = 1.0 megohm, f = 100 Hz) | 2N4220A 2N4221A 2N4222A | NF | | | 2.5 2.5 2.5 | dB |

^{*}Pulse Test: Pulse Width = 630 ms, Duty Cycle = 10%.

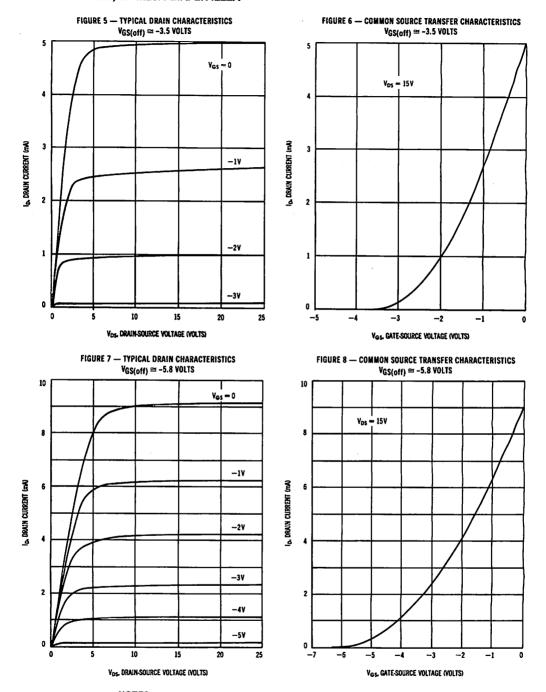








2N4220 thru 2N4222, 2N4220A thru 2N4222A



- NOTES: 1. Graphical data is presented for dc conditions. Tabular data is given for pulsed conditions (Pulse Width = 630 ms, Duty Cycle = 10%). Under dc conditions, self heating in higher IDSS units reduces IDSS (See Figure 10).
 - Figures 8, 9, 10: Data taken in a standard printed circuit with a TO-18 type socket mounting and 1/4" lead length.

2N4223 2N4224

CASE 20-03, STYLE 3 TO-72 (TO-206AF)

JFET VHF AMPLIFIER

N-CHANNEL - DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|------------------|-------------|-------------|
| Drain-Source Voltage | VDS | 30 | Vdc |
| Drain-Gate Voltage | V_{DG} | 30 | Vdc |
| Gate-Source Voltage | VGS | -30 | Vdc |
| Drain Current | ΙD | 20 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 2.0 | mW mW/°C |
| Operating and Junction Temperature Range | TJ | -65 to +175 | ှင |
| Storage Temperature Range | T _{sta} | -65 to +175 | °C |

| Characteristic | | Symbol | Min | Max | Unit |
|--|------------------|------------------|--------------|------------------|-------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (IG = -10 µAdc, VDS = 0) | | V(BR)GSS | -30 | _ | Vdc |
| Gate Reverse Current (VGS = -20 Vdc, V _{DS} = 0) | 2N4223 2N4224 | IGSS | = | - 0.25 - 0.50 | nAdc |
| (VGS = -20 Vdc, VDS = 0, TA = 100°C) | 2N4223 2N4224 | | | -250 -500 | |
| Gate Source Cutoff Voltage (I _D = 0.25 nAdc, V _{DS} = 15 Vdc) (I _D = 0.50 nAdc, V _{DS} = 15 Vdc) | 2N4223 2N4224 | VGS(off) | -1.2 | -8.0 -8.0 | Vdc |
| Gate Source Voltage (I _D = 0.3 mAdc, V _{DS} = 15 Vdc) (I _D = 0.2 mAdc, V _{DS} = 15 Vdc) | 2N4223 2N4224 | V _{GS} | 1.0 1.0 | -7.0 -7.5 | Vdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current* (VDS = 15 Vdc, VGS = 0) | 2N4223 2N4224 | [†] DSS | 3.0 2.0 | 18 20 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transfer Admittance (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz)* | 2N4223 2N4224 | lYfsl | 3000 2000 | 7000 7500 | μmhos |
| $(V_{DS} = 15 \text{ Vdc}, V_{GS} = 0, f = 200 \text{ MHz})$ | 2N4223 2N4224 | | 2700 1700 | _ | |
| Input Conductance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 200 MHz) | | Re(yis) | _ | 800 | μmhos |
| Output Conductance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 200 MHz) | | Re(yos) | | 200 | μmhos |
| Input Capacitance (VDS = 15 Vdc, VGS = 0, f = 1.0 MHz) | | C _{iss} | _ | 6.0 | pF |
| Reverse Transfer Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz) | | C _{rss} | _ | 2.0 | pF |

2N4223, 2N4224

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|---|--------|-----------------|-----|-----|------|
| FUNCTIONAL CHARACTERISTICS | | • | | | |
| Noise Figure (VDS = 15 Vdc, VGS = 0, RS = 1.0 k ohm, f = 200 MHz) | 2N4223 | NF | _ | 5.0 | dB |
| Small-Signal Power Gain Common Source (Vps = 15 Vdc, Vgs = 0, f = 200 MHz) | 2N4223 | G _{ps} | 10 | _ | dB |

^{*}Pulse Test: Pulse Width ≤ 630 ms, Duty Cycle ≤ 10%.

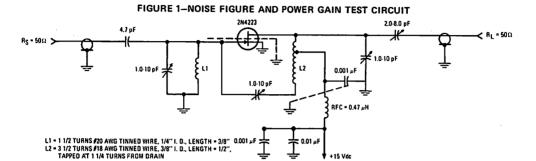


FIGURE 2 —

DRAIN CURRENT versus GATE-SOURCE VOLTAGE

25

20

VDS * 15 Vdc

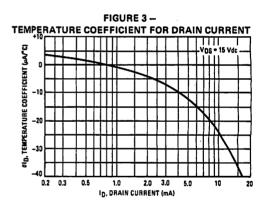
15

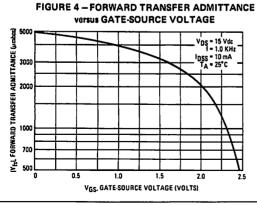
125°C

7A* -55°C

0 1.0 2.0 3.0 4.0 5.

Vgs, GATE-SOURCE VOLTAGE (VOLTS)





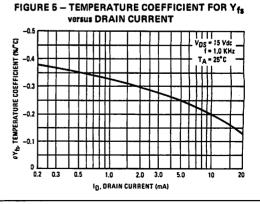


FIGURE 6 - CAPACITANCES

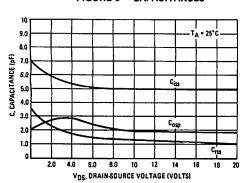


FIGURE 7 - COMMON SOURCE NOISE FIGURE versus SOURCE RESISTANCE f = 105 MHz 9.0 V_{DS} = 15 V I_D = 4.0 mA T_A = 25°C 8.0 9 7.0 NF, NOISE FIGURE 6.0 5.0 4.0 3.0 2.0 1.0 0 0.1 0.2 0.3 0.5 1.0 2.0 3.0 5.0 10 RS, SOURCE RESISTANCE (k chms)

FIGURE 8 - INPUT ADMITTANCE versus FREQUENCY

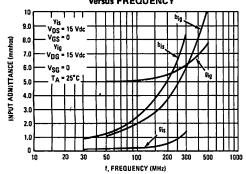


FIGURE 9 - FORWARD TRANSFER ADMITTANCE

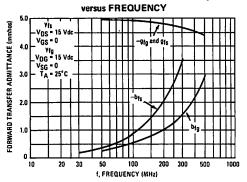


FIGURE 10 - OUTPUT ADMITTANCE

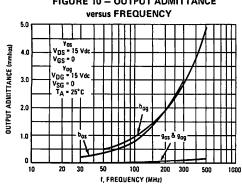


FIGURE 11 - REVERSE TRANSFER ADMITTANCE

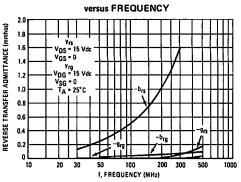


FIGURE 12 - POWER GAIN versus FREQUENCY

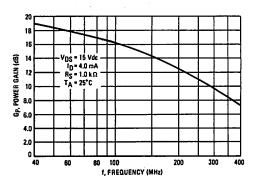
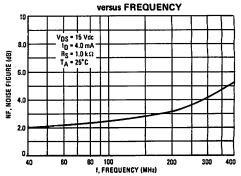


FIGURE 13 – COMMON SOURCE NOISE FIGURE



2N4338 2N4339 2N4340 2N4341

CASE 22-03, STYLE 3 TO-18 (TO-206AA)

JFET LOW-FREQUENCY, LOW NOISE

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|-------------|
| Drain-Source Voltage | VDS | 50 | Vdc |
| Drain-Gate Voltage | V _{DG} | 50 | Vdc |
| Gate-Source Voltage | VGS | 50 | Vdc |
| Reverse Gate-Source Voltage | VGSR | 50 | Vdc |
| Gate Current | IG | 50 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 2.0 | mW mW/°C |
| Storage Temperature Range | T _{stg} | -65 to +200 | °C |

| Characteristic | | Symbol | Min | Max | Unit |
|---|--------------------------------------|------------------|------------------------------|----------------------------------|-------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (IG = -1.0 µA) | | V(BR)GSS | 50 | _ | Vdc |
| Gate Reverse Current (VGS = -30 V) | | IGSS | | 0.1 | nA. |
| Gate Source Cutoff Voltage (V _{DS} = 15 V, I _D = 0.1 μA) | 2N4338 2N4339 2N4340 2N4341 | VGS(off) | -0.3 -0.6 -1.0 -2.0 | - 1.0 - 1.8 - 3.0 - 6.0 | Vdc |
| ON CHARACTERISTICS | | | | | _ |
| Zero-Gate-Voltage Drain Current (V _{DS} = 15 V) | 2N4338 2N4339 2N4340 2N4341 | loss* | 0.2 0.5 1.2 3.0 | 0.6 1.5 3.6 9.0 | mA |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transfer Admittance (Vps = 15 V, f = 1.0 kHz) | 2N4338 2N4339 2N4340 2N4341 | vfs * | 600 800 1300 2000 | 1800 2400 3000 4000 | μmhos |
| Output Admittance (VDS = 15 V, f = 1.0 kHz) | 2N4338 2N4339 2N4340 2N4341 | lyosl | | 5.0 15 30 60 | μmhos |
| Input Capacitance (VDS = 15 V, f = 1.0 MHz) | | Ciss | _ | 6.0 | pF |
| Reverse Transfer Capacitance (VDS = 15 V, f = 1.0 MHz) | | C _{rss} | | 2.0 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | | |
| Noise Figure (VDS = 15 Volts, $f = 1.0 \text{ kHz}$, $R_G = 1.0 \text{ M}\Omega$) | | NF | _ | 1.0 | dB |

^{*}Pulse Test: Pulse Width ≤ 630 msec, Duty Cycle ≤ 10%.

2N4342

CASE 29-02, STYLE 7 TO-92 (TO-226AA)

JFET HIGH FREQUENCY, LOW NOISE

P-CHANNEL — DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|-------------|
| Drain-Source Voltage | VDS | -25 | Vdc |
| Drain-Gate Voltage | VDG | -25 | Vdc |
| Reverse Gate-Source Voltage | VGSR | 25 | Vdc |
| Forward Gate Current | IGF | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 310 2.82 | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +125 | °C |

Refer to 2N5460 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|----------------------|------|-----------|--------------|
| OFF CHARACTERISTICS | | | | |
| Gate-Source Breakdown Voltage (IG = 10 μAdc, VDS = 0) | V(BR)GSS | 25 | _ | Vdc |
| Gate Reverse Current (VGS = 15 Vdc, VDS = 0) (VGS = 15 Vdc, VDS = 0, TA = 65°C) | IGSS | = | 10 0.5 | nAdc µAdc |
| Gate Source Cutoff Voltage (Vps = -10 Vdc, lp = 1.0μ Adc) | VGS(off) | 1.0 | 5.5 | Vdc |
| Gate Source Voltage (Vps = -10 Vdc, lp = 0.4 mAdc) (Vps = -10 Vdc, lp = 1.0 mAdc) | V _{GS} | 0.7 | 5.0 | Vdc |
| ON CHARACTERISTICS | | | | |
| Zero-Gate-Voltage Drain Current (Vps = -10 Vdc, Vgs = 0) | loss | 4.0 | 12 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Drain-Source "ON" Resistance (VGS = 0, ID = 0, f = 1.0 kHz) | ^r ds(on) | _ | 700 | Ohms |
| Forward Transfer Admittance (V _{DS} = -10 Vdc, V _{GS} = 0, f = 1.0 kHz) | Yfs | 2000 | 6000 | μmhos |
| Output Admittance (Vps = -10 Vdc, Vgs = 0, f = 1.0 kHz) | Ivosl | _ | 75 | μmhos |
| Common Source Forward Transconductance (VDS = -10 Vdc, VGS = 0, f = 1.0 MHz) | Re(y _{fs}) | 1500 | _ | μmhos |
| Input Capacitance (VDS = -10 Vdc, VCS = 0, f = 1.0 MHz) | C _{iss} | _ | 20 | pF |
| Reverse Transfer Capacitance (Vps = -10 Vdc, Vgs = 0, f = 1.0 MHz) | C _{rss} | _ | 5.0 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | |
| Noise Figure (V _{DS} = -10 Vdc, V _{GS} = 0, R _G = 1.0 Megohm, f = 100 Hz, BW = 15 Hz) | NF | _ | 1.5 | dB |
| Equivalent Short-Circuit Input Noise Voltage (VDS = -10 Vdc, VGS = 0, f = 100 Hz, BW = 15 Hz) | En | _ | 80.0 | μV/√Hz |

MAXIMUM RATINGS

| MAXIMUM KATINGS | | | |
|--|-----------------|-------------|-------------|
| Rating | Symbol | Value | Unit |
| Drain-Source Voltage | V _{DS} | 25 | Vdc |
| Drain-Gate Voltage | VDG | 30 | Vdc |
| Gate-Source Voltage* | VGS | 30 | Vdc |
| Drain Current | lp | 30 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 1.7 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 800 4.56 | mW mW/°C |
| Junction Temperature Range | TJ | 175 | °C |
| Storage Temperature Range | Teta | -65 to +175 | °C |

^{*}Transient potentials of ±75 Volt will not cause gate-oxide failure.

2N4351

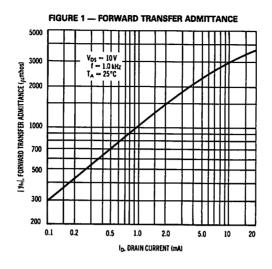
CASE 20-03, STYLE 2 TO-72 (TO-206AF)

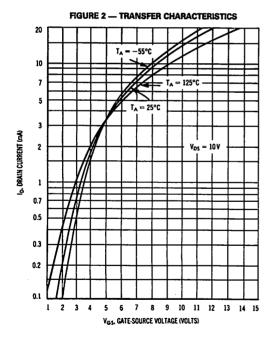
> MOS FET SWITCHING

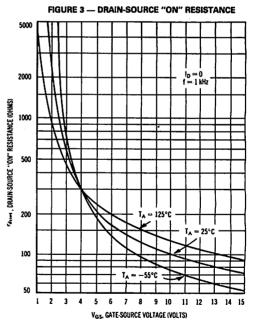
N-CHANNEL — ENHANCEMENT

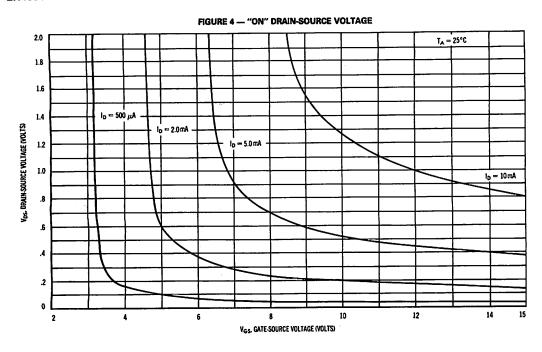
| ELECTRICAL | CHARACTERISTICS ITA = | 25°C unless otherwise noted.) |
|------------|-----------------------|-------------------------------|
| | | |

| Characteristic | Symbol | Min | Max | Unit |
|--|---------------------|------|----------|--------------|
| OFF CHARACTERISTICS | | | | |
| Drain-Source Breakdown Voltage (I _D = 10 μA, V _{GS} = 0) | V(BR)DSX | 25 | _ | Vdc |
| Zero-Gate-Voltage Drain Current (VDS = 10 V, VGS = 0) T _A = 25°C T _A = 150°C | IDSS | | 10 10 | nAdc μAdc |
| Gate Reverse Current $(V_{GS} = \pm 15 \text{ Vdc}, V_{DS} = 0)$ | IGSS | _ | ±10 | pAdc |
| ON CHARACTERISTICS | | | | |
| Gate Threshold Voltage (V _{DS} = 10 V, I _D = 10 μ A) | VGS(Th) | 1.0 | 5 | Vdc |
| Drain-Source On-Voltage (Ip = 2.0 mA, VGS = 10 V) | V _{DS(on)} | _ | 1.0 | V |
| On-State Drain Current (VGS = 10 V, VDS = 10 V) | ID(on) | 3.0 | _ | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Forward Transfer Admittance {Vps = 10 V, Ip = 2.0 mA, f = 1.0 kHz} | lyfsl | 1000 | _ | μmho |
| Input Capacitance (VDS = 10 V, VGS = 0, f = 140 kHz) | C _{iss} | - | 5.0 | pF |
| Reverse Transfer Capacitance (Vps = 0, Vgs = 0, f = 140 kHz) | C _{rss} | - | 1.3 | pF |
| Drain-Substrate Capacitance (VD(SUB) = 10 V, f = 140 kHz) | C _{d(sub)} | _ | 5.0 | pF |
| Drain-Source Resistance (VGS = 10 V, ID = 0, f = 1.0 kHz) | rds(on | _ | 300 | ohms |
| SWITCHING CHARACTERISTICS | | | | |
| Turn-On Delay (Fig. 5) | t _{d1} | _ | 45 | ns |
| Rise Time (Fig. 6) ID = 2.0 mAdc, VDS = 10 Vdc, | tr | _ | 65 | ns |
| Turn-Off Delay (Fig. 7) VGS = 10 Vdc) (See Figure 9; Times Circuit Determined) | t _{d2} | _ | 60 | ns |
| Fall Time (Fig. 8) | tf | _ | 100 | ns |









SWITCHING CHARACTERISTICS

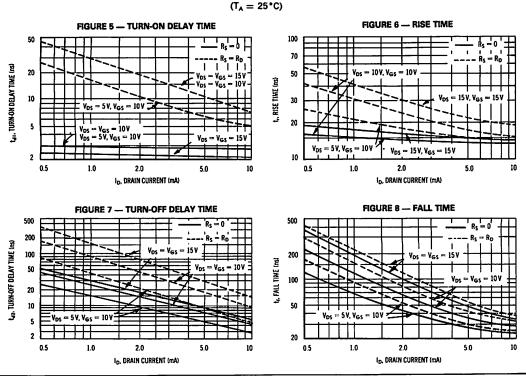
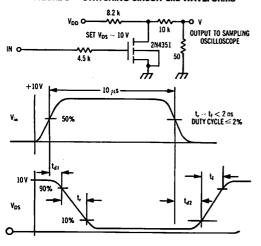


FIGURE 9 - SWITCHING CIRCUIT and WAVEFORMS



The switching characteristics shown above were measured in a test circuit similar to Figure 10. At the beginning of the switching interval, the gate voltage is at ground and the gate-source

capacitance ($C_{\rm gs} = C_{\rm iss} - C_{\rm rss}$) has no charge. The drain voltage is at V_{DD}, and thus the feedback capacitance ($C_{\rm rss}$) is charged to V_{DD}. Similarly, the drain-substrate capacitance ($C_{\rm d(sub)}$) is charged to V_{DD} since the substrate and source are connected to ground.

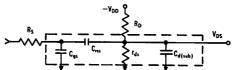
During the turn-on interval, C_{gs} is charged to V_{GS} (the input voltage) through R_S (generator impedance). C_{res} must be discharged to $V_{GS} - V_{D(on)}$ through R_S and the parallel combination of the load resistor (R_D) and the channel resistance (r_{ds}). In addition, $C_{d(sub)}$ is discharged to a low value ($V_{D(on)}$) through R_D in parallel with r_{ds} . During turn-off this charge flow is reversed.

Predicting turn-on time proves to be somewhat difficult since the channel resistance $(r_{\rm ds})$ is a function of the gate-source voltage (VGS). As $C_{\rm gs}$ becomes charged, VGS is approaching Vin and $r_{\rm ds}$ decreases (see Figure 4) and since $C_{\rm FSS}$ and $C_{\rm d(sub)}$ are charged through $r_{\rm ds}$, turn-on time is quite non-linear.

If the charging time of C_{gs} is short compared to that of C_{rss} and $C_{d(sub)}$, then r_{ds} (which is in parallel with R_D) will be low compared to R_D during the switching interval and will largely determine the turn-on time. On the other hand, during turn-off r_{ds} will be almost an open circuit requiring C_{rss} and $C_{d(sub)}$ to be charged through R_D and resulting in a turn-off time that is long compared to the turn-on time. This is especially noticeable for the curves where $R_S=0$ and C_{gs} is charged through the pulse generator impedance only.

The switching curves shown with $R_S=R_D$ simulate the switching behavior of cascaded stages where the driving source impedance is normally the same as the load impedance. The set of curves with $R_S=0$ simulates a low source impedance drive such as might occur in complementary logic circuits.

FIGURE 10 — SWITCHING CIRCUIT MOSFET EQUIVALENT MODEL



2N4352

CASE 20-03, STYLE 2 TO-72 (TO-206AF)

MOS FET SWITCHING

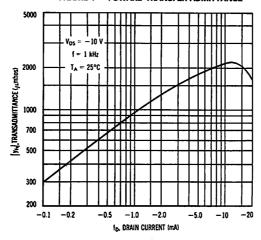
P-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|-------------|
| Drain-Source Voltage | VDS | 25 | Vdc |
| Drain-Gate Voltage | VDG | 30 | Vdc |
| Gate-Source Voltage | VGS | ±30 | Vdc |
| Gate Current | lG | 30 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 1.7 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 800 4.56 | mW mW/°C |
| Junction Temperature Range | TJ | 175 | °C |
| Storage Temperature Range | T _{sta} | -65 to +175 | °C |

| | Characteristic | Symbol | Min | Max | Unit |
|--|---|----------------------|-------|--------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Drain-Source Breakdown (ID = -10 μA, VGS = | | V _{(BR)DSX} | -25 | _ | Vdc |
| Zero-Gate-Voltage Drain (VDS = -10 V, VGS = | | IDSS | = | - 10 - 10 | nAdc µAdc |
| Gate Reverse Current (VGS = ±30 V, VDS = | = 0) | GSS | _ | ± 10 | pAdc |
| ON CHARACTERISTICS | | | | | |
| Gate Threshold Voltage (VDS = -10 V, ID = | – 10 <i>μ</i> A) | VGS(Th) | - 1.0 | -5.0 | Vdc |
| Drain-Source On-Voltage (ID = −2.0 mA, VGS | | V _{DS(on)} | - | - 1.0 | ٧ |
| On-State Drain Current (VGS = -10 VDS = - | - 10 V) | lD(on) | -3.0 | - | mA |
| SMALL-SIGNAL CHARA | CTERISTICS | | | | |
| Drain-Source Resistance (VGS = -10 V, ID = 0 | 0, f = 1.0 kHz) | ^r ds(on) | | 600 | ohms |
| Forward Transfer Admitt (VDS = -10 V, ID = 2 | | lYfsl | 1000 | _ | μmho |
| Input Capacitance (VDS = -10 V, VGS = | = 0, f = 140 kHz) | C _{iss} | | 5.0 | pF |
| Reverse Transfer Capacit (VDS = 0, VGS = 0, f | | C _{rss} | _ | 1.3 | pF |
| Drain-Substrate Capacita (VD(SUB) = -10 V, f | | C _{d(sub)} | _ | 4.0 | pF |
| SWITCHING CHARACTE | RISTICS | | | | |
| Turn-On Delay (Figures 5) | | t _{d1} | _ | 45 | ns |
| Rise Time (Figures 6) | Ip = -2.0 mAdc, Vps = -10 Vdc, | t _r | | 65 | ns |
| Turn-Off Delay (Figures 7) | VGS = -10 V) (See Figure 9, Times Circuit Determined) | ^t d2 | _ | 60 | ns |
| Fall Time (Figures 8) | | tf | _ | 100 | ns |

FIGURE 1 — FOWARD TRANSFER ADMITTANCE





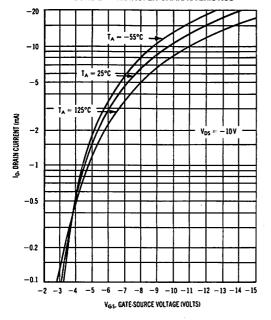
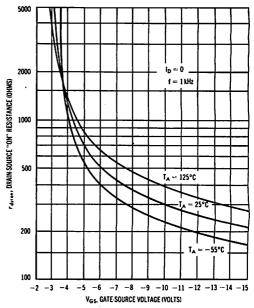
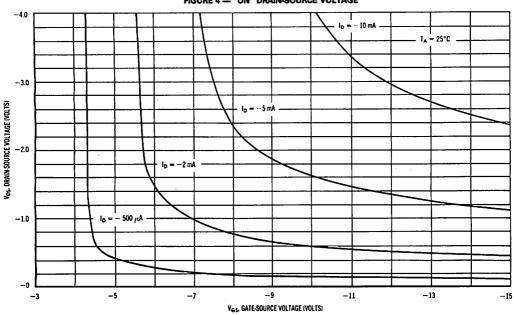


FIGURE 3 — DRAIN-SOURCE "ON" RESISTANCE







SWITCHING CHARACTERISTICS (T_A = 25°C)

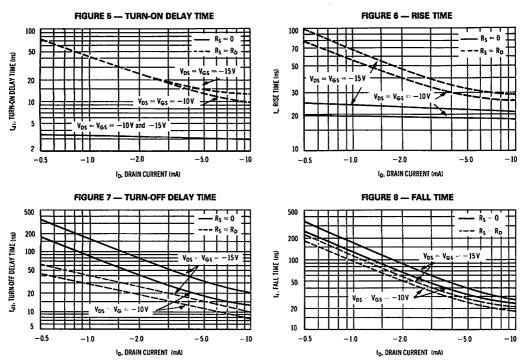
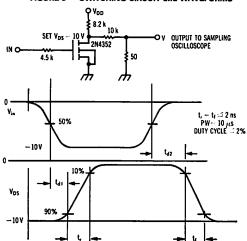


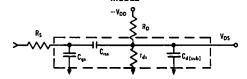
FIGURE 9 — SWITCHING CIRCUIT and WAVEFORMS



The switching characteristics shown above were measured in a test circuit similar to Figure 10. At the beginning of the switching interval, the gate voltage is at ground and the gate-source capacitance (C₀, = C_{····} —C_{···}) has no charge. The drain voltage is at Voo. and thus the feedback capacitance (C₀-is) is charged to Voo. Similarly, the drain-substrate capacitance (C₀-is) is charged to Voo. Similarly, the drain-substrate capacitance (C₀-is) is charged to Voo. Similarly, the drain-substrate capacitance (C₀-is) is charged to Voo. Considered to Voo. The substrate and source are connected to ground.

During the turn-on interval, C₀-is charged to Voo. The input voltage) through Rs, and the parallel combination of the load resistor(Ro) and the channel resistance (C₀-i, in addition, C₀-is) is identified to the charged to a low value (Voi-in) through Ro in the charge (Voi-in) is a function of the gate-source voltage (Voi-in). A C₀-in becomes charged Voi-is a sproaching V₀-and r₀-decreases (see Figure 4) and since C₀-in and C₀-in-jar e charged through r₀-i, turn-on time is quite non-linear. If the charging time of C₀-is short compared to that of C₀-in and C₀-in-jar e charged through r₀-i, turn-on time con the other hand, during interval and will largely determine the turn-on time. On the other hand, during interval and will largely determine the turn-on time. On the other hand, during interval and will largely determine the curves where Rs = O and C₀-is is charged through Ro and resulting in a turn-off time that is long compared to the turn-on time. This is expecially noticeable for the curves where Rs = O and C₀-is is charged through Ro and resulting in a turn-off time that is long compared to the turn-on time. Bin is expecially noticeable for the curves where Rs = O and C₀-is is charged through Ro and resulting in a furn-off time that is long compared to the turn-on time. This is expecially noticeable for the curves where Rs = O simulate the switching behavior of cacaca

FIGURE 10 — SWITCHING CIRCUIT with MOSFET EQUIVALENT MODEL



2N4360

CASE 29-02, STYLE 7 TO-92 (TO-226AA)

JFET LOW-FREQUENCY/LOW-NOISE

P-CHANNEL — DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|-------------|
| Drain-Source Voltage | V _{DS} | 20 | Vdc |
| Drain-Gate Voltage | V _{DG} | 20 | Vdc |
| Gate-Source Voltage | VGS | 20 | Vdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 310 2.82 | mW mW/°C |
| Storage Temperature Range | T _{sto} | -55 to +125 | °C |

Refer to 2N5460 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|------|------|-------|
| OFF CHARACTERISTICS | | | | |
| Gate-Source Breakdown Voltage (IG = 10 μA) | V(BR)GSS | 20 | _ | Vdc |
| Gate Reverse Current (VGS = 15) | lgss | | 10 | nA , |
| Gate Source Cutoff Voltage $(V_{DS} = -10 \text{ V, } I_{D} = 1.0 \mu\text{A})$ | VGS(off) | 0.7 | 10.0 | Vdc |
| Gate Source Voltage (ID = 0.3 mA, VDS = -10 V) | V _{GS} | 0.4 | 9.0 | Vdc |
| ON CHARACTERISTICS | | | | |
| Zero-Gate-Voltage Drain Current (VDS = -10 V, VGS = 0 V) | loss | 3.0 | 30 | mA |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Drain-Source "ON" Resistance (ID = 0, VGS = 0, f = 1.0 kHz) | ^r ds | | 700 | Ohms |
| Forward Transfer Admittance (VDS = -10 V, VGS = 0 V, f = 1.0 kHz) | lyfsl | 2000 | 8000 | μmhos |
| Output Admittance (V _{DS} = -10 V, V _{GS} = 0 V, f = 1.0 kHz) | lYosi | _ | 100 | μmhos |
| Common Source Forward Transconductance (VDS = -10 V, VGS = 0 V, f = 1.0 MHz) | Re(y _{fs}) | 1500 | - | μmhos |
| Input Capacitance (VDS = -10 V, f = 1.0 MHz) | C _{iss} | _ | 20 | pF |
| Reverse Transfer Capacitance (Vps = -10 V, f = 1.0 MHz) | C _{rss} | _ | 5.0 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | |
| Noise Figure $(V_{DS} = -10 \text{ V}, I_{D} = 1.0 \text{ mA}, R_{G} = 1.0 \text{ m}\Omega, f = 100 \text{ Hz})$ | NF | - | 5.0 | d₿ |

2N4391 2N4392 2N4393

CASE 22-03, STYLE 2 TO-18 (TO-206AA)

JFET SWITCHING

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-------------------|-------------|----------------|
| Drain-Source Voltage | V _{DS} | 40 | Vdc |
| Drain-Gate Voltage | V _{DG} | 40 | Vdc |
| Gate-Source Voltage | V _{GS} . | 40 | Vdc |
| Forward Gate Current | IGF | 50 | mAdc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.8 10 | Watts mW/°C |
| Operating Junction Temperature Range | TJ | -65 to +175 | °C |
| Storage Temperature Range | T _{sta} | -65 to +175 | °C |

Refer to MPF4391 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|--|---------------------|---|---------------------------------|--------------|
| OFF CHARACTERISTICS | <u> </u> | | | | |
| Gate-Source Breakdown Voltage (I _G = 1.0 μAdc, V _{DS} = 0) | | V(BR)GSS | 40 | _ | Vdc |
| Gate Reverse Current (VGS = 20 Vdc, VDS = 0) (VGS = 20 Vdc, VDS = 0, TA = 150°C) | | IGSS | _ | 0.1 0.2 | nAdc |
| Gate Source Voltage (Vps = 20 Vdc, lp = 1.0 nAdc) | 2N4391 2N4392 2N4393 | V _{GS} | 4.0 2.0 0.5 | 10 5.0 3.0 | μAdc Vdc |
| Gate-Source Forward Voltage (I _G = 1.0 mAdc, V _{DS} = 0) | | V _{GS(f)} | _ | 1.0 | Vdc |
| Drain-Cutoff Current (VDS = 20 Vdc, VGS = 12 Vdc) (VDS = 20 Vdc, VGS = 7.0 Vdc) (VDS = 20 Vdc, VGS = 5.0 Vdc) (VDS = 20 Vdc, VGS = 12 Vdc, TA = 150°C) (VDS = 20 Vdc, VGS = 7.0 Vdc, TA = 150°C) (VDS = 20 Vdc, VGS = 5.0 Vdc, TA = 150°C) | 2N4391 2N4392 2N4393 2N4391 2N4392 2N4393 | ^I D(off) | = | 0.1 0.1 0.1 0.2 0.2 | nAdc μAdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current(1) (VDS = 20 Vdc, VGS = 0) | 2N4391 2N4392 2N4393 | loss | 50 25 5.0 | 150 75 30 | mAdc |
| Drain-Source On-Voltage (ID = 12 mAdc, VGS = 0) (ID = 6.0 mAdc, VGS = 0) (ID = 3.0 mAdc, VGS = 0) | 2N4391 2N4392 2N4393 | V _{DS(on)} | = | 0.4 0.4 0.4 | Vdc |
| Static Drain-Source On Resistance (ID = 1.0 mAdc, VGS = 0) | 2N4391 2N4392 2N4393 | ^r DS(on) | = | 30 60 100 | Ohms |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Drain-Source "ON" Resistance (VGS = 0, ID = 0, f = 1.0 kHz) | 2N4391 2N4392 2N4393 | ^r ds(on) | = | 30 60 100 | Ohms |

2N4391, 2N4392, 2N4393

| Characteristic | | Symbol | Min | Max | Unit |
|---|----------------------------|------------------|---------------|-------------------|------|
| Input Capacitance (Vps = 20 Vdc, Vgs = 0, f = 1.0 MHz) | | C _{iss} | _ | 14 | pF |
| Reverse Transfer Capacitance (VDS = 0, VGS = 12 Vdc, f = 1.0 MHz) (VDS = 0, VGS = 7.0 Vdc, f = 1.0 MHz) (VDS = 0, VGS = 5.0 Vdc, f = 1.0 MHz) SWITCHING CHARACTERISTICS | 2N4391 2N4392 2N4393 | C _{rss} | = | 3.5 3.5 3.5 | pF |
| Rise Time (ID(on) = 12 mAdc) (ID(on) = 6.0 mAdc) (ID(on) = 3.0 mAdc) | 2N4391 2N4392 2N4393 | t _r | = | 5.0 5.0 5.0 | ns |
| Fall Time (VGS(off) = 12 Vdc) (VGS(off) = 7.0 Vdc) (VGS(off) = 5.0 Vdc) | 2N4391 2N4392 2N4393 | tf | <u>-</u> - | 15 20 30 | ns |
| Turn-On Time (ID(on) = 12 mAdc) (ID(on) = 6.0 mAdc) (ID(on) = 6.0 mAdc) (ID(on) = 3.0 mAdc) | 2N4391 2N4392 2N4393 | ton | = | 15 15 15 | ns |
| Turn-Off Time (VGS(off) = 12 Vdc) (VGS(off) = 7.0 Vdc) (VGS(off) = 5.0 Vdc) | 2N4391 2N4392 2N4393 | toff | _ _ _ | 20 35 50 | ns |

⁽VGS(off) = 5.0 Vdc)
(1) Pulse Test: Pulse Width ≤ 100 μs, Duty Cycle ≤ 1.0%.
*In addition to JEDEC Registered Data.

2N4416,A

CASE 20-03, STYLE 1 TO-72 (TO-206AF)

JFET VHF/UHF AMPLIFIER

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

| Rating | | Symbol | Value | Unit |
|--|-------------------|-----------------------------------|-------------|-------------|
| Drain-Source Voltage | | VDS | 30 | Vdc |
| Drain-Gate Voltage | 2N4416 2N4416A | V _{DG} | 35 30 | Vdc |
| Gate-Source Voltage | | VGS | 30 | Vdc |
| Gate Current | | lg. | 10 | mAdc |
| Total Device Dissipation @ T, Derate above 25°C | A = 25°C | PD | 300 1.71 | mW mW/°C |
| Operating and Storage Juncti Temperature Range | ion | T _J , T _{stg} | -65 to +175 | °C |

| Characteristic | | Symbol | Min | Max | Unit |
|---|-------------------|--------------------|----------|----------------|----------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (I _G = 1.0 μAdc, V _{DS} = 0) | 2N4416 2N4416A | V(BR)GSS | 30 35 | | Vdc |
| Gate Reverse Current (VGS = 20 Vdc, V _{DS} = 0) (VGS = 20 Vdc, V _{DS} = 0, T _A = +150°C) | | lgss | _ | 100 200 | pAdc |
| Gate Source Cutoff Voltage (Ip = 1.0 nAdc, Vps = 15 Vdc) | | VGS(off) | _ | 6.0 | Vdc |
| Gate Source Voltage (I _D = 0.5 mAdc, V _{DS} = 15 Vdc) | | VGS | 1.0 | 5.5 | Vdc |
| Gate-Source Forward Voltage (IG = 1.0 mAdc, VDS = 0) | | V _{GS(f)} | _ | 1.0 | Vdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current(1) (VDS = 15 Vdc, VGS = 0) | • | IDSS | 5.0 | 15 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | <u> </u> |
| Forward Transfer Admittance(1) (Vps = 15 Vdc, Vgs = 0, f = 1.0 kHz) | | lyfsl | 4500 | 7500 | μmhos |
| Real Part of Forward Transfer Admittance ($V_{DS} = 15 \text{ Vdc}$, $V_{GS} = 0$, $f = 400 \text{ MHz}$) | | Yfs(real) | 4000 | _ | μmhos |
| Real Part of Input Admittance (VDS = 15 Vdc, VGS = 0, f = 100 MHz) (VDS = 15 Vdc, VGS = 0, f = 400 MHz) | | Yis(real) | | 100 1000 | μmhos |
| Output Admittance (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz) | | lyosi | - | 50 | μmhos |
| Real Part of Output Admittance (VDS = 15 Vdc, VGS = 0, f = 100 MHz) (VDS = 15 Vdc, VGS = 0, f = 400 MHz) | | Yos(real) | = | 75 100 | μmhos |
| Imaginary Part of Input Admittance (VDS = 15 Vdc, VGS = 0, f = 100 MHz) (VDS = 15 Vdc, VGS = 0, f = 400 MHz) | | Yis(imag) | | 2500 10,000 | μmhos |
| Imaginary Part of Output Admittance (VDS = 15 Vdc, VGS = 0, f = 100 MHz) (VDS = 15 Vdc, VGS = 0, f = 400 MHz) | | Yos(imag) | | 1000 4000 | μmhos |

2N4416,A

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|--|------------------|-----|-----|------|
| Input Capacitance (Vps = 15 Vdc, Vgs = 0, f = 1.0 MHz) | C _{iss} | - | 4.0 | pF |
| Reverse Transfer Capacitance (Vps = 15 Vdc, Vgs = 0, f = 1.0 MHz) | C _{rss} | _ | 0.8 | pF |
| Common Source Output Capacitance (VDS = 15 Vdc, VGS = 0, f = 1.0 MHz) | Coss | | 2.0 | pF |

FUNCTIONAL CHARACTERISTICS

| Noise Figure (Figures 3 and 4) | NF | | | dB |
|--|-----|----------------|-----|----|
| (VDS = 15 Vdc, ID = 5.0 mAdc, Rg = 1000 Ohms, f = 100 MHz) | | l — | 2.0 | |
| (VDS = 15 Vdc, tD = 5.0 mAdc, Rg ≈ 1000 Ohms, f = 400 MHz) | | L - | 4.0 | |
| Small-Signal Power Gain Common Source (Figure 1) | Gps | | | dB |
| (VDS = 15 Vdc, ID = 5.0 mAdc, f = 100 MHz) | | 18 | - | |
| (VDS = 15 Vdc, ID = 5.0 mAdc, f = 400 MHz) | | 10 | | |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 1.0%.

POWER GAIN FIGURE 1 - EFFECTS OF DRAIN CURRENT

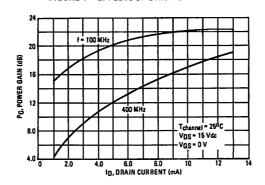
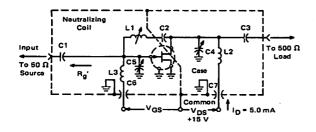


FIGURE 2 - 100 MHz and 400 MHz NEUTRALIZED TEST CIRCUIT



NOTE:

| | V _{GS} < 0 Volts | test receiver (AIL type 136 | | lent). |
|----|----------------------------------|-----------------------------|------|--------|
| L1 | 17 turns, (approx. – depends upo | | **L1 | 6 tur |

Adjust V_{GS} for I_D = 50 mA

Reference

Designation C1

C2

СЗ

C4

C5

C6

C7

L1 L2

L3

VALUE

400 MHz

1.8 pF

17 pF

1.0 pF

0.8-8.0 pF

0.8-8.0 pF

0.001 µF

0.001 µF

0.2 μΗ**

0.03 µH**

0.022 µH*

100 MHz

7.0 pF

1000 pF

3.0 pF

1-12 pF

1-12 pF

0.0015 µF

0.0015 µF

3.0 µH°

0.15 µH°

0.14 µH*

The noise source is a hot-cold body

(AIL type 70 or equivalent) with a

form. Tuning provided by a powdered iron slug. 4-1/2 turns, AWG #18 enameled copper wire, 5/16" long, 3/8" I.D. (AIR CORE).

^{3-1/2} turns, AWG #18 enameled copper wire, 1/4" long, 3/8" I.D. (AIR CORE).

^{**}L1 6 turns, (approx. – depends upon circuit layout) AWG #24 enameled copper wire, close wound on 7/32" ceramic coil

¹ turn, AWG #16 enameled copper wire, 3/8" I.D. (AIR CORE).

^{1/2} turn, AWG #16 enameled copper wire, 1/4" I.D. (AIR CORE).

form. Tuning provided by an aluminum slug.

SMALL-SIGNAL DEVICES

NOISE FIGURE (T_{channel} = 25°C)

FIGURE 3 - EFFECTS OF DRAIN-SOURCE VOLTAGE

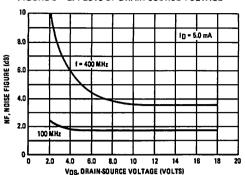
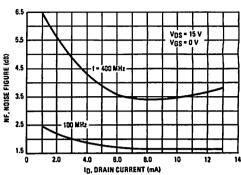
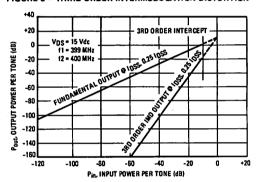


FIGURE 4 - EFFECTS OF DRAIN CURRENT



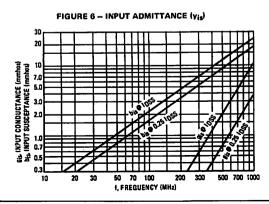
INTERMODULATION CHARACTERISTICS

FIGURE 5 - THIRD ORDER INTERMODULATION DISTORTION

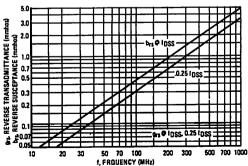


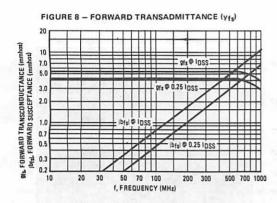
COMMON SOURCE CHARACTERISTICS

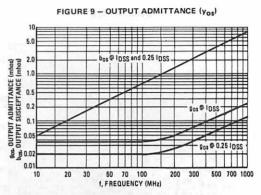
ADMITTANCE PARAMETERS (VDS = 15 Vdc, T_{channel} = 25°C)

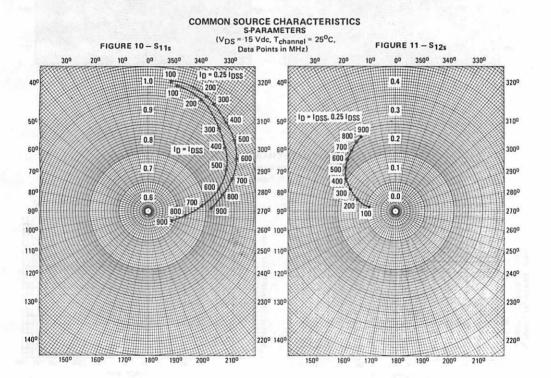


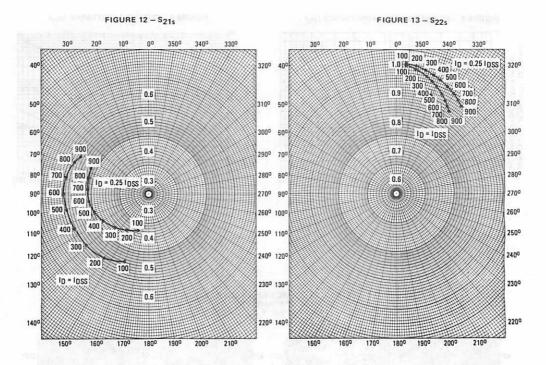




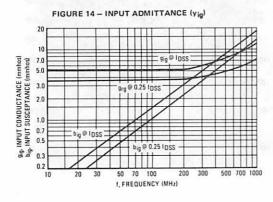


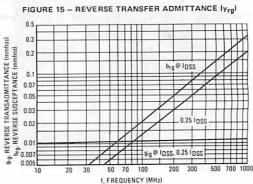


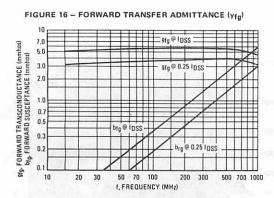


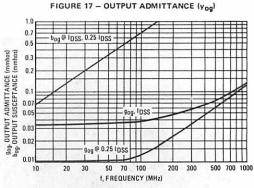


COMMON GATE CHARACTERISTICS ADMITTANCE PARAMETERS (VDG = 15 Vdc, T_{channel} = 25°C)

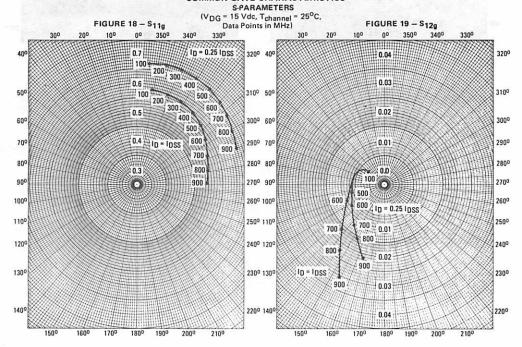


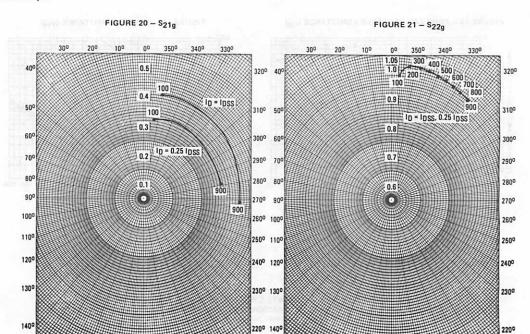






COMMON GATE CHARACTERISTICS





2N4856,A thru 2N4861,A

MAXIMUM RATINGS

| Rating | Symbol | 2N4856,A 2N4857,A 2N4858,A | 2N4859,A 2N4880,A 2N4881,A | Unit |
|--|------------------|----------------------------------|----------------------------------|-------------|
| Drain-Source Voltage | VDS | +40 | +30 | Vdc |
| Drain-Gate Voltage | V _{DG} | +40 | +30 | Vdc |
| Reverse Gate-Source Voltage | VGSR | -40 | -30 | Vdc |
| Forward Gate Current | IGF | 50 | | mAdc |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 360 2.4 | | mW mW/°C |
| Storage Temperature Range | T _{stg} | -65 to +175 | | ℃ |

JAN, JTX AVAILABLE CASE 22-03, STYLE 4 TO-18 (TO-206AA)

> JFET SWITCHING

N-CHANNEL - DEPLETION

| ELECTRICAL | . CHARACTERISTICS (T | \ = | 25°C unless otherwise noted.) |
|------------|----------------------|------------|-------------------------------|
|------------|----------------------|------------|-------------------------------|

| Characte | ristic | Symbol | Min | Max | Unit |
|--|--|---------------------|----------------------|----------------------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (IG = 1.0 μAdc, VDS = 0) | 2N4856,A, 2N4857,A, 2N4858,A 2N4859,A, 2N4860,A, 2N4861,A | V(BR)GSS | -40 -30 | | Vdc |
| Gate Reverse Current (VGS = -20 Vdc, VDS = 0) (VGS = -15 Vdc, VDS = 0) (VGS = -20 Vdc, VDS = 0, TA = 150°C) (VGS = -15 Vdc, VDS = 0, TA = 150°C) | | lgss | - - - - | 0.25 0.25 0.5 0.5 | nAdc μAdc |
| Gate Source Cutoff Voltage (V _{DS} = 15 Vdc, I _D = 0.5 nAdc) | 2N4856,A, 2N4859,A 2N4857,A, 2N4860,A 2N4858,A, 2N4861,A | VGS(off) | -4.0 -2.0 -0.8 | - 10 - 6.0 - 4.0 | Vdc |
| Drein Cutoff Current (VDS = 15 Vdc, VGS = -10 Vdc) (VDS = 15 Vdc, VGS = -10 Vdc, TA = 1 | 50°C) | ^I D(off) | | 0.25 0.5 | nAdc μAdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current(1) (VDS = 15 Vdc, VGS = 0) | 2N4856,A, 2N4859,A 2N4857,A, 2N4860,A 2N4858,A, 2N4861,A | IDSS | 50 20 8.0 | — 100 80 | mAdc |
| Drain-Source On-Voltage (ID = 20 mAdc, VGS = 0) (ID = 10 mAdc, VGS = 0) (ID = 5.0 mAdc, VGS = 0) | 2N4856,A, 2N4859,A 2N4857,A, 2N4860,A 2N4858,A, 2N4861,A | V _{DS(on)} | <u>=</u> | 0.75 0.5 0.5 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Drain-Source "ON" Resistance (VGS = 0, ID = 0, f = 1.0 kHz) | 2N4856,A, 2N4859,A 2N4857,A, 2N4860,A 2N4858,A, 2N4861,A | ^r ds(on) | | 25 40 60 | Ohms |
| Input Capacitance (VDS = 0, VGS = -10 Vdc, f = 1.0 MHz) | 2N4856 thru 2N4861 2N4856A thru 2N4861A | C _{iss} | _ | 18 10 | pF |
| Reverse Transfer Capacitance (VDS = 0, VGS = -10 Vdc, f = 1.0 MHz) | 2N4856 thru 2N4861 2N4856A, 2N4859A 2N4857A, 2N4858A, 2N4860A, 2N4861A | C _{rss} | = | 8.0 4.0 3.5 | pF |

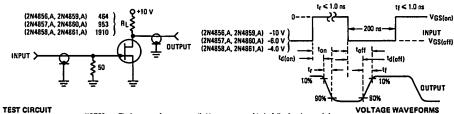
2N4856,A thru 2N4861,A

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| | Characteristic | | Symbol | Min | Max | Unit |
|--------------------|---|--|--------------------|-----------------------|---------------------------------------|------|
| SWITCHING CHARACT | ERISTICS (See Figure 1) (2) | | | | | |
| Turn-On Delay Time | (VDD = 10 Vdc, ID(on) = 20 mAdc, VGS(on) = 0, VGS(off) = -10 Vdc) | | ^t d(on) | _ _ _ _ _ | 6.0 5.0 6.0 6.0 10 8.0 | ns |
| Rise Time | Conditions for 2N4857,A, 2N4860,A: (VDD = 10 Vdc, ID(on) = 10 mAdc, VGS(on) = 0, VGS(off) = -6.0 Vdc) | 2N4857,A, 2N4860,A 2N4858, 2N4861 | t _r | | 3.0 4.0 10 8.0 | ns |
| Turn-Off Time | Conditions for 2N4858,A, 2N4861,A: (VDD = 10 Vdc, l _{D(on)} = 5.0 mAdc, VGS(on) = 0. VGS(off) = -4.0 Vdc) | 2N4856, 2N4859 2N4856A, 2N4859A 2N4857, 2N4860 2N4857A, 2N4860A | ^t off | | 25 20 50 40 100 80 | ns |

⁽¹⁾ Pulse Test: Pulse Width = 100 ms, Duty Cycle ≤ 10%.

FIGURE 1 - SWITCHING TIMES TEST CIRCUIT



NOTES: a. The input waveforms are supplied by a generator with the following characteristics:

⁽²⁾ The ID(on) values are nominal; exact values vary slightly with transistor parameters.

 $[\]begin{split} Z_{Out} = & 50 \text{ ohms. Duty Cycle} \approx 2.0\%. \\ \text{b. Waveforms are monitored on an oscilloscope with the following characteristics:} \\ & t_{c} \leq 0.75 \text{ ns. Rin} > 1.0 \text{ magohm. Cin} \leq 2.5 \text{ pF.} \end{split}$

2N5245⁶ 2N5246 2N5247

CASE 29-02, STYLE 23 TO-92 (TO-226AA)

JFET HIGH-FREQUENCY AMPLIFIER

N-CHANNEL - DEPLETION

Refer to 2N4416 for graphs.

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|------------------|-------------|-------------|
| Drain-Gate Voltage | V _{DG} | 30 | Vdc |
| Gate-Source Voltage | V _{GS} | -30 | Vdc |
| Gate Current | IG | 50 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C (Free Air) | PD | 360 2.88 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 500 4.0 | mW mW/°C |
| Lead Temperature (1/16" from Case for 10 Seconds) | TL | 260 | °C |
| Storage Temperature Range | T _{stg} | -65 to +150 | °C |

| Characteristic | | Symbol | Min | Max | Unit |
|--|--|----------------------|----------------------------|-------------------------------|----------|
| OFF CHARACTERISTICS | | | | - - | |
| Gate-Source Breakdown Voltage (IG = -1.0μ A, VDS = 0) | | V(BR)GSS | -30 | - | Vdc |
| Gate Reverse Current (VGS = -20 V, VDS = 0) | | IGSS | | -1.0 | пА |
| Gate 1 Leakage Current $(V_{G1S} = -20 \text{ V}, V_{DS} = 0, T_A = 100^{\circ}\text{C})$ | | lG1SS | _ | -0.5 | μА |
| Gate Source Cutoff Voltage (V _{DS} = 15 V, I _D = 10 mA) | 2N5245 2N5246 2N5247 | VGS(off) | 1.0 0.5 1.5 | - 6.0 - 4.0 - 8.0 | Vdc |
| ON CHARACTERISTICS | | | | | <u> </u> |
| Zero-Gate-Voltage Drain Current (VDS = 15 V, VGS = 0, Pulsed: See Note 1) | 2N5245 2N5246 2N5247 | IDSS | 5.0 1.5 8.0 | 15 7.0 24 | mA |
| SMALL-SIGNAL CHARACTERISTICS | | | | | Ł |
| Forward Transfer Admittance (VDS = 15 V, VGS = 0, f = 1.0 kHz) | 2N5245 2N5246 2N5247 | İYfsl | 4500 3000 4500 | 7500 6000 8000 | μmhos |
| Input Admittance (VDS = 15 V, VGS = 0) | (100 MHz) (400 MHz) | Re(yis) | | 100 1000 | μmhos |
| Output Admittance (V _{DS} = 15 V, V _{GS} = 0, f = 1.0 kHz) | 2N5245 2N5246 2N5247 | lyosl | = | 50 50 70 | μmhos |
| Output Conductance (V _{DS} = 15 V, V _{GS} = 0) | 2N5245 (100 MHz) 2N5246 2N5247 2N5245 (400 MHz) 2N5246 2N5247 | Re(y _{OS}) | - - - - - - | 75 75 100 100 100 | μmhos |

2N5245, 2N5246, 2N5247

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|---|--------------------------------------|----------------------|----------------------|--------------|-------|
| Forward Transconductance (VDS = 15 V, VGS = 0, f = 400 MHz) | 2N5245 2N5246 2N5247 | Re(y _{fs}) | 4000 2500 4000 | = | μmhos |
| Input Capacitance (VDS = 15 V, VGS = 0, f = 1.0 Mhz) | | C _{iss} | <u>-</u> | 4.5 | pF |
| Reverse Transfer Capacitance (Vps = 15 V, Vgs = 0, f = 1.0 MHz) | · | C _{rss} | _ | 1.0 | pF |
| Input Susceptance (VDS = 15 V, VGS = 0) | (100 MHz) (400 MHz) | I _M (Yis) | <u>-</u> | 3.0 12.0 | mmho |
| FUNCTIONAL CHARACTERISTICS | | | | | |
| Noise Figure (VDS = 15 V, l_D = 5.0 mA, R'G = 1.0 k Ω) | | NF | _ | 2.0 4.0 | dB |
| Common Source Power Gain (VDS = 15 V, ID = 5.0 mA, R'G = 1.0 k Ω) | 2N5245 (100 MHz) 2N5245 (400 MHz) | G _{ps} | 18 10 | | dB |
| Output Susceptance (VDS = 15 V, VGS = 0) | (100 MHz) (400 MHz) | I _M (Yos) | = | 1000 4000 | μmho |

Note 1: tp = 100 ms, Duty Cycle = 10%.

2N5265 thru 2N5270

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|-------------|
| Drain-Source Voltage | V _{DS} | 60 | Vdc |
| Drain-Gate Voltage | VDG | 60 | Vdc |
| Reverse Gate-Source Voltage | VGSR | 60 | Vdc |
| Drain Current | I _D | 20 | mAdc |
| Forward Gate Current | lGF | 10 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 2.0 | mW mW/°C |
| Junction Temperature Range | TJ | -65 to +175 | •€ |
| Storage Temperature Range | T _{sta} | -65 to +200 | °C |

CASE 20-05, STYLE 5 TO-72 (TO-206AF)

JFET GENERAL PURPOSE

P-CHANNEL — DEPLETION

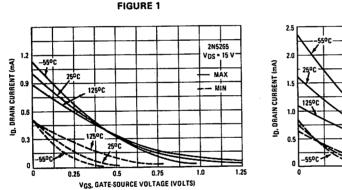
| Characteristic | | Symbol | Min | Max | Unit |
|--|----------------|---|------|------|----------|
| OFF CHARACTERISTICS | | | | | 1 |
| Gate-Source Breakdown Voltage | | V(BR)GSS | 60 | | Vdc |
| (IG = 10 μAdc, VDS = 0) | | 1 (2,000 | | | 1 |
| Gate Reverse Current | | IGSS | | | |
| $(V_{GS} = 30 \text{ Vdc}, V_{DS} = 0)$ | | 333 | | 2.0 | nAdc |
| (VGS = 30 Vdc, VDS = 0, TA = 150°C) | | | · == | 2.0 | μAdc |
| Gate Source Cutoff Voltage | | V _{GS(off)} | | 1 | Vdc |
| $(V_{DS} = 15 \text{ Vdc}, I_{D} = 1.0 \mu\text{Adc})$ | 2N5265, 2N5266 | 33(011) | | 3.0 | *** |
| | 2N5267, 2N5268 | i i | _ | 6.0 | 1 |
| | 2N5269, 2N5270 | | _ | 8.0 | 1 |
| Gate Source Voltage | · | VGS | | | Vdc |
| $(V_{DS} = 15 \text{ Vdc}, I_{D} = 0.05 \text{ mAdc})$ | 2N5265 | '65 | 0.3 | 1.5 | 1 |
| $(V_{DS} = 15 \text{ Vdc}, I_{D} = 0.08 \text{ mAdc})$ | 2N5266 | | 0.4 | 2.0 | 1 |
| $(V_{DS} = 15 \text{ Vdc}, I_{D} = 0.15 \text{ mAdc})$ | 2N5267 | | 1.0 | 4.0 | |
| (VDS = 15 Vdc, ID = 0.25 mAdc) | 2N5268 | 1. 1 | 1.0 | 4.0 | |
| (VDS = 15 Vdc, ID = 0.4 mAdc) | 2N5269 | | 2.0 | 6.0 | |
| (V _{DS} = 15 Vdc, I _D = 0.7 mAdc) | 2N5270 | - | 2.0 | 6.0 | l |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current | | IDSS | | | mAdc |
| $(V_{DS} = 15 \text{ Vdc}, V_{GS} = 0)$ | 2N5265 | 555 | 0.5 | 1.0 | l linauc |
| | 2N5266 | | 0.8 | 1.6 | |
| | 2N5267 | 1 | 1.5 | 3.0 | |
| | 2N5268 | 1 1 | 2.5 | 5.0 | |
| | 2N5269 | | 4.0 | 8.0 | |
| | 2N5270 | | 7.0 | 14 | İ |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transfer Admittance | | lyfsl | | | μmhos |
| (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz) | 2N5265 | ''''' | 900 | 2700 | μιιιιος |
| | 2N5266 | | 1000 | 3000 | 1 |
| | 2N5267 | | 1500 | 3500 | l . |
| | 2N5268 | 1 1 | 2000 | 4000 | ļ |
| | 2N5269 | | 2200 | 4500 | |
| | 2N5270 | | 2500 | 5000 | ŀ |
| Output Admittance Common Source | | Iyosl | | 75 | μmhos |
| $(V_{DS} = 15 \text{ Vdc}, V_{GS} = 0, f = 1.0 \text{ kHz})$ | |] .,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, | | | |

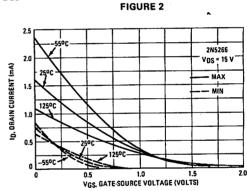
2N5265 thru 2N5270

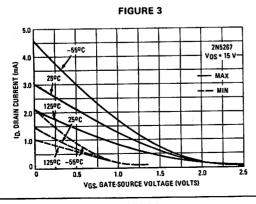
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

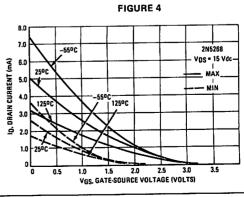
| Characteristic | | Symbol | Min | Max | Unit |
|--|--|----------------------|--|-----|--------|
| Common Source Forward Transconductance (VDS = 18 Vdc, VGS = 0, f = 100 MHz) | 2N5265 2N5266 2N5267 2N5268 2N5269 2N5270 | Re(y _{fs}) | 800 900 1400 1700 1900 2100 | | μmhos |
| Input Capacitance (VDS = 15 Vdc, VGS = 0, f = 1.0 MHz) | | Ciss | _ | 7.0 | pF |
| Reverse Transfer Capacitance (VDS = 15 Vdc, VGS = 0, f = 1.0 MHz) | | C _{rss} | - . | 2.0 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | | т |
| Noise Figure ($V_{DS} = 15$ Vdc, $V_{GS} = 0$, $R_{G} = 1.0$ M ohm, $f = 100$ Hz, $BW = 1.0$ Hz) | | NF | _ | 2.5 | dB |
| Equivalent Short-Circuit Input Noise Voltage (Vps = 15 Vdc, Vgs = 0, f = 100 Hz, BW = 1.0 Hz |) | e _n | - | 115 | nV/√Hz |

FIGURE 1-6 TRANSFER CHARACTERISTIC CURVES FOR MIN/MAX IDSS LIMITS

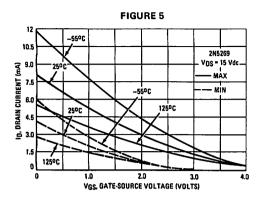


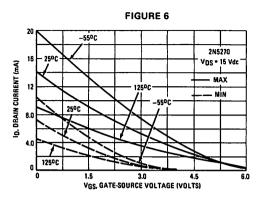




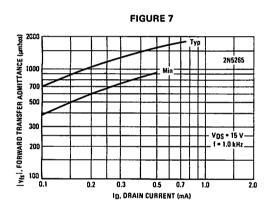


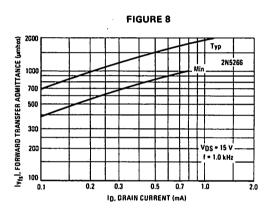
SMALL-SIGNAL DEVICES

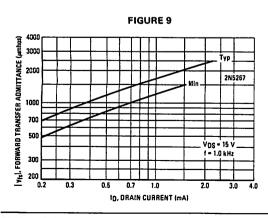


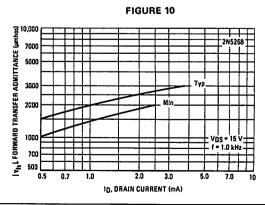


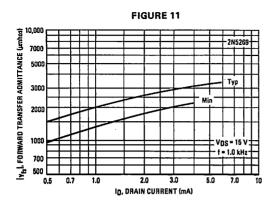
FIGURES 7-12 - TYPICAL AND MINIMUM FORWARD TRANSFER ADMITTANCE

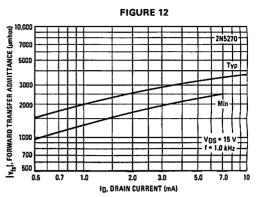




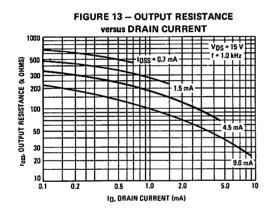


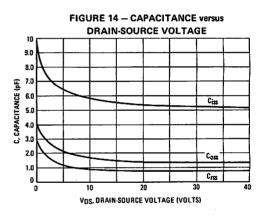


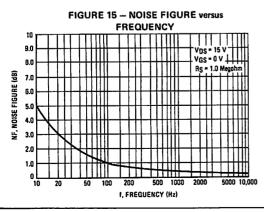


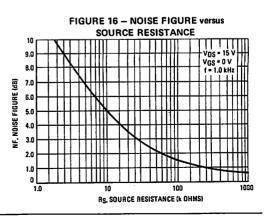


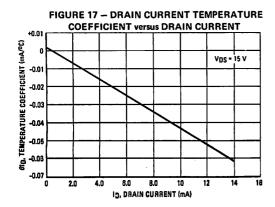
TYPICAL CURVES

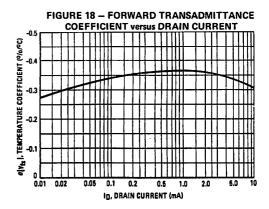












2N5457 2N5458 2N5459

CASE 29-05, STYLE 5 TO-92 (TO-226AA)

JFET GENERAL PURPOSE

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

| MAXIMUM RATINGS | | | |
|---|------------------|-------------|-------------|
| Rating | Symbol | Value | Unit |
| Drain-Source Voltage | VDS | 25 | Vdc |
| Drain-Gate Voltage | VDG | 25 | Vdc |
| Reverse Gate-Source Voltage | VGSR | - 25 | Vdc |
| Gate Current | IG | 10 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 310 2.82 | mW mW/°C |
| Junction Temperature Range | TJ | 125 | °C |
| Storage Channel Temperature Range | T _{stg} | -65 to +150 | င |

Refer to 2N4220 for graphs.

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|----------------------------|-----------------------|-------------------------|-------------------------|----------------------|-------|
| OFF CHARACTERISTICS | | • | | | | |
| Gate-Source Breakdown Voltage (IG = -10 µAdc, VDS = 0) | | V _(BR) GSS | - 25 | 1 | _ | Vdc |
| Gate Reverse Current (VGS = -15 Vdc, VDS = 0) (VGS = -15 Vdc, VDS = 0, TA = 100° C) | | IGSS | 1 1 | 11 | - 1.0 - 200 | nAdc |
| Gate Source Cutoff Voltage (VDS = 15 Vdc, ID = 10 nAdc) | 2N5457 2N5458 2N5459 | VGS(off) | - 0.5 - 1.0 - 2.0 | | -6.0 -7.0 -8.0 | Vdc |
| Gate Source Voltage (V _{DS} = 15 Vdc, I _D = 100 μAdc) (V _{DS} = 15 Vdc, I _D = 200 μAdc) (V _{DS} = 15 Vdc, I _D = 400 μAdc) | 2N5457 2N5458 2N5459 | V _{GS} | | - 2.5 - 3.5 - 4.5 | <u>-</u> | Vdc |
| ON CHARACTERISTICS | | | - | | | |
| Zero-Gate-Voltage Drain Current* (VDS = 15 Vdc, VGS = 0) | 2N5457 2N5458 2N5459 | loss | 1.0 2.0 4.0 | 3.0 6.0 9.0 | 5.0 9.0 16 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | • | | • | | |
| Forward Transfer Admittance Common Source* (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz) | 2N5457 2N5458 2N5459 | lyfsl | 1000 1500 2000 | = | 5000 5500 6000 | μmhos |
| Output Admittance Common Source* (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz) | | lyosl | _ | 10 | 50 | μmhos |
| Input Capacitance (Vps = 15 Vdc, Vgs = 0, f = 1.0 MHz) | | C _{iss} | _ | 4.5 | 7.0 | pF |
| Reverse Transfer Capacitance (VDS = 15 Vdc, VGS = 0, f = 1.0 MHz) | | C _{rss} | _ | 1.5 | 3.0 | pF |

^{*}Pulse Test: Pulse Width ≤ 630 ms; Duty Cycle ≤ 10%.

2N5460 thru 2N5465

MAXIMUM RATINGS

| Rating | Symbol | 2N5460 2N5461 2N5462 | 2N5463 2N5464 2N5465 | Unit |
|---|------------------|----------------------------|----------------------------|-------------|
| Drain-Gate Voltage | VDG | 40 | 60 | Vdc |
| Reverse Gate-Source Voltage | VGSR | 40 | 60 | Vdc |
| Forward Gate Current | lG(f) | 10 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 310 2.82 | | mW mW/°C |
| Junction Temperature Range | TJ | -65 to +135 | | °C |
| Storage Channel Temperature Range | T _{sta} | -65 to +150 | | င့ |

CASE 29-02, STYLE 7 TO-92 (TO-226AA)

> JFET AMPLIFIER

P-CHANNEL — DEPLETION

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|---------------------------------------|------------------|------|-----|------|----------|
| OFF CHARACTERISTICS | | | | | | |
| Gate-Source Breakdown Voltage | | V(BR)GSS | | | | Vdc |
| $(I_G = 10 \ \mu Adc, V_{DS} = 0)$ | 2N5460, 2N5461, 2N5462 | ,, | 40 | _ | l – | |
| | 2N5463, 2N5464, 2N5465 | | 60 | _ | - | |
| Gate Reverse Current | | IGSS | | | | |
| $(V_{GS} = 20 \text{ Vdc}, V_{DS} = 0)$ | 2N5460, 2N5461, 2N5462 | | _ ' | _ | 5.0 | nAdc |
| (VGS = 30 Vdc, VDS = 0) | 2N5463, 2N5464, 2N5465 | 1 | _ | _ | 5.0 | |
| (VGS = 20 Vdc, VDS = 0, TA = 100°C) | 2N5460, 2N5461, 2N5462 | | _ | _ | 1.0 | μAdc |
| (VGS = 30 Vdc, VDS = 0, TA = 100°C) | 2N5463, 2N5464, 2N5465 | | _ | | 1.0 | ' |
| Gate Source Cutoff Voltage | | VGS(off) | | | | Vdc |
| $(V_{DS} = 15 \text{ Vdc}, I_{D} = 1.0 \mu\text{Adc})$ | 2N5460, 2N5463 |] | 0.75 | _ | 6.0 | |
| | 2N5461, 2N5464 | | 1.0 | _ | 7.5 | 1 |
| | 2N5462, 2N5465 | <u> </u> | 1.8 | - | 9.0 | 1 |
| Gate Source Voltage | | VGS | | | | Vdc |
| $(V_{DS} = 15 \text{ Vdc}, I_{D} = 0.1 \text{ mAdc})$ | 2N5460, 2N5463 | " | 0.5 | _ | 4.0 | |
| $(V_{DS} = 15 \text{ Vdc}, I_{D} = 0.2 \text{ mAdc})$ | 2N5461, 2N5464 | | 0.8 | _ | 4.5 | 1 |
| (VDS = 15 Vdc, ID = 0.4 mAdc) | 2N5462, 2N5465 | | 1.5 | _ | 6.0 | ł |
| ON CHARACTERISTICS | | | | | | |
| Zero-Gate-Voltage Drain Current | | IDSS | | | | mAdo |
| $(V_{DS} = 15 \text{ Vdc}, V_{GS} = 0,$ | 2N5460, 2N5463 | | 1.0 | _ | 5.0 | |
| f = 1.0 kHz) | 2N5461, 2N5464 | | 2.0 | _ | 9.0 | ľ |
| | 2N5462, 2N5465 | | 4.0 | - | 16 | |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Forward Transfer Admittance | | lyfs | | | | μmhos |
| $(V_{DS} = 15 \text{ Vdc}, V_{GS} = 0, f = 1.0 \text{ kHz})$ | 2N5460, 2N5463 | } | 1000 | _ | 4000 | , |
| | 2N5461, 2N5464 | j l | 1500 | _ | 5000 | 1 |
| | 2N5462, 2N5465 | | 2000 | _ | 6000 | |
| Output Admittance | | Yos | _ | _ | 75 | μmhos |
| (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz) | | "" | | | | |
| Input Capacitance | | Ciss | | 5.0 | 7.0 | pF |
| (VDS = 15 Vdc, VGS = 0, f = 1.0 MHz) | | -185 | | | , | " |
| Reverse Transfer Capacitance | | C _{rss} | | 1.0 | 2.0 | pF |
| (VDS = 15 Vdc, VGS = 0, f = 1.0 MHz) | | orss | | 1.0 | 2.0 | PP- |
| FUNCTIONAL CHARACTERISTICS | 4.0 | -l | | | | 1 |
| Noise Figure | · · · · · · · · · · · · · · · · · · · | NF | | 1.0 | 2.5 | 40 |
| (VDS = 15 Vdc, VGS = 0, RG = 1.0 Megoh | m, f = 100 Hz, BW = 1.0 Hz) | "" | _ | 1.0 | 2.5 | dB |
| Equivalent Short-Circuit Input Noise Voltage | | | | 60 | 115 | -100 (5) |
| (VDS = 15 Vdc, VGS = 0, f = 100 Hz, BW = | 4.0.11-1 | e _n | _ | 60 | 115 | nV/√H |

DRAIN CURRENT versus GATE SOURCE VOLTAGE



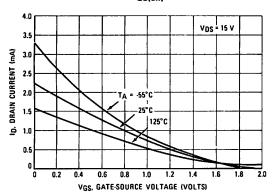


FIGURE 2 - VGS(off) = 4.0 VOLTS

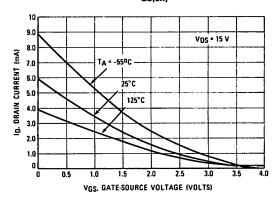
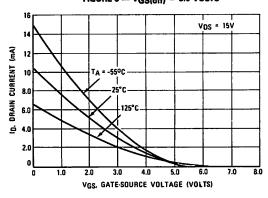


FIGURE 3 - VGS(off) = 5.0 VOLTS



FORWARD TRANSFER ADMITTANCE versus DRAIN CURRENT

FIGURE 4 - VGS(off) = 2.0 VOLTS

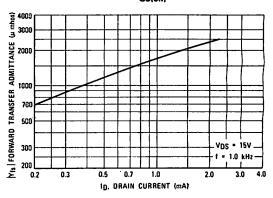


FIGURE 5 - VGS(off) = 4.0 VOLTS

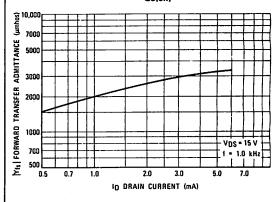
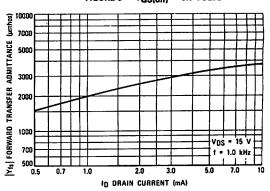
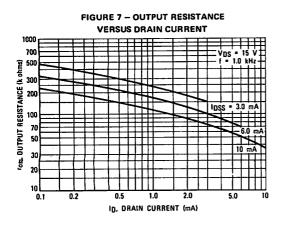
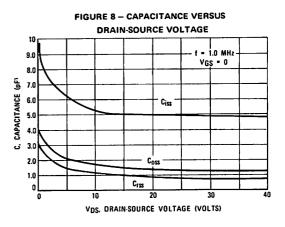
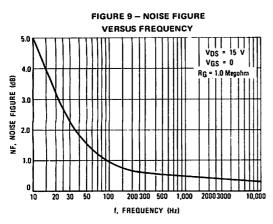


FIGURE 6 - VGS(off) = 5.0 VOLTS









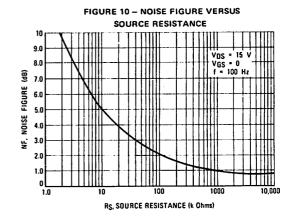
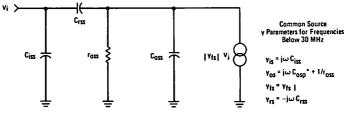


FIGURE 11 - EQUIVALENT LOW FREQUENCY CIRCUIT



*Cosp is Coss in parallel with Series Combination of Ciss and Crss.

NOTE:

Graphical data is presented for dc conditions. Tabular data is given for pulsed conditions (Pulse Width + 630 ms, Duty Cycle + 100.)

2N5484 thru 2N5486

CASE 29-05, STYLE 5 TO-92 (TO-226AA)

JFET VHF/UHF AMPLIFIER

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

| WANINGH NATINGS | | | |
|---|-----------------------------------|-------------|------------|
| Rating | Symbol | Value | Unit |
| Drain-Gate Voltage | VDG | 25 | Vdc |
| Reverse Gate-Source Voltage | VGSR | 25 | Vdc |
| Drain Current | ĺD | 30 | mAdc |
| Forward Gate Current | lG(f) | 10 | mAdc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 310 2.82 | mW mW/℃ |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +150 | °C |

Refer to 2N4416 for graphs.

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|----------------------------|----------------------|----------------------|-------------|----------------------|--------------|
| OFF CHARACTERISTICS | | | | | | |
| Gate-Source Breakdown Voltage (I _G = -1.0 μAdc, V _{DS} = 0) | | V(BR)GSS | - 25 | _ | _ | Vdc |
| Gate Reverse Current (VGS = -20 Vdc, VDS = 0) (VGS = -20 Vdc, VDS = 0, TA = 100°C) | | IGSS | = | = | - 1.0 - 0.2 | nAdc µAdc |
| Gate Source Cutoff Voltage (V _{DS} = 15 Vdc, t _D = 10 nAdc) | 2N5484 2N5485 2N5486 | VGS(off) | -0.3 -0.5 -2.0 | _ _ _ | -3.0 -4.0 -6.0 | Vdc |
| ON CHARACTERISTICS | | | | | | |
| Zero-Gate-Voltage Drain Current (VDS = 15 Vdc, VGS = 0) | 2N5484 2N5485 2N5486 | PDSS | 1.0 4.0 8.0 | _ _ _ | 5.0 10 20 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Forward Transfer Admittance (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz) | 2N5484 2N5485 2N5486 | lYfsl | 3000 3500 4000 | | 6000 7000 8000 | μmhos |
| Input Admittance (VDS = 15 Vdc, VGS = 0, f = 100 MHz) (VDS = 15 Vdc, VGS = 0, f = 400 MHz) | 2N5484 2N5485, 2N5486 | Re(y _{is}) | = | _ | 100 1000 | μmhos |
| Output Admittance (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz) | 2N5484 2N5485 2N5486 | lyosl | = | = | 50 60 75 | μmhos |
| Output Conductance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 100 MHz) (V _{DS} = 15 Vdc, V _{GS} = 0, f = 400 MHz) | 2N5484 2N5485, 2N5486 | Re(yos) | _ | <u>-</u> | 75 100 | μmhos |
| Forward Transconductance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 100 MHz) | 2N5484 | Re(y _{fs}) | 2500 | _ | _ | μmhos |
| $(V_{DS} = 15 \text{ Vdc}, V_{GS} = 0, f = 400 \text{ MHz})$ | 2N5485 2N5486 | | 3000 3500 | _ | | |

2N5484 thru 2N5486

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|--|------------------|---------------------|-------------------|-------------------------------|------|
| Input Capacitance (Vps = 15 Vdc, Vgs = 0, f = 1.0 MHz) | - | C _{iss} | _ | 1 | 5.0 | pF |
| Reverse Transfer Capacitance (Vps = 15 Vdc, Vgs = 0, f = 1.0 MHz) | | C _{rss} | | - | 1.0 | pF |
| Output Capacitance (Vps = 15 Vdc, Vgs = 0, f = 1.0 MHz) | | Coss | _ | - | 2.0 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | | | |
| Noise Figure (VDS = 15 Vdc, VGS = 0, RG = 1.0 Megohm, f = (VDS = 15 Vdc, Ip = 1.0 mAdc, RG = 1.0 k ohm, f = 100 MHz) (VDS = 15 Vdc, Ip = 1.0 mAdc, RG = 1.0 k ohm, f = 200 MHz) (VDS = 15 Vdc, Ip = 4.0 mAdc, RG = 1.0 k ohm, f = 100 MHz) (VDS = 15 Vdc, Ip = 4.0 mAdc, RG = 1.0 k ohm, f = 100 MHz) (VDS = 15 Vdc, Ip = 4.0 mAdc, RG = 1.0 k ohm, f = 400 MHz) | 1.0 kHz) 2N5484 2N5484 2N5485, 2N5486 2N5485, 2N5486 | NF | - - - | 4.0 - | 2.5 3.0 — 2.0 4.0 | dB |
| Common Source Power Gain (VDS = 15 Vdc, ID = 1.0 mAdc, f = 100 MHz) (VDS = 15 Vdc, ID = 1.0 mAdc, f = 200 MHz) (VDS = 15 Vdc, ID = 4.0 mAdc, f = 100 MHz) (VDS = 15 Vdc, ID = 4.0 mAdc, f = 400 MHz) | 2N5484 2N5484 2N5485, 2N5486 2N5485, 2N5486 | Gps | 16 — 18 10 | _ 14 _ _ | 25 — 30 20 | dΒ |

2N5555

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET SWITCHING

N-CHANNEL — DEPLETION

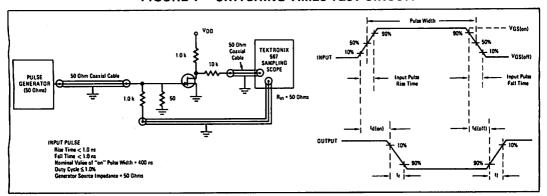
MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|------------------|-------------|-------------|
| Drain-Source Voltage | V _{DS} | 25 | Vdc |
| Drain-Gate Voltage | VDG | 25 | Vdc |
| Gate-Source Voltage | VGS | 25 | Vdc |
| Forward Gate Current | IGF | 10 | mAdc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 310 2.82 | mW mW/°C |
| Junction Temperature Range | TJ | -65 to +150 | °C |
| Storage Temperature Range | T _{stg} | -65 to +150 | ů |

| | Characteristic S | | <u>M</u> in | Max | Unit |
|--|--|---------------------|-------------|-----------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown (IG = 10 μAdc, VDS = | | V(BR)GSS | 25 | _ | Vdc |
| Gate Reverse Current (VGS = 15 Vdc, VDS = | : 0) | ^I GSS | | 1.0 | nAdc |
| Drain Cutoff Current (VDS = 12 Vdc, VGS = (VDS = 12 Vdc, VGS = | | lD(off) | _ | 10 2.0 | nAdc μAdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain (VDS = 15 Vdc, VGS = | | IDSS | 15 | _ | mAdc |
| Gate-Source Forward Vol (IG(f) = 1.0 mAdc, Vps | • | VGS(f) | _ | 1.0 | Vdc |
| Drain-Source On-Voltage | | V _{DS(on)} | - | 1.5 | Vdc |
| Static Drain-Source On R | ** | rDS(on) | _ | 150 | Ohms |
| SMALL-SIGNAL CHARA | | • | | • | |
| Small-Signal Drain-Source (VGS = 0, ID = 0, f = | | rds(on) | _ | 150 | Ohms |
| Input Capacitance (Vps = 15 Vdc, Vgs = | = 0, f = 1.0 MHz) | C _{iss} | - | 5.0 | pF |
| Reverse Transfer Capacit (Vps = 0, Vgs = 10 \ | | C _{rss} | _ | 1.2 | pF |
| SWITCHING CHARACTE | RISTICS | | | | |
| Turn-On Delay Time | $(V_{DD} = 10 \text{ Vdc}, I_{D(on)} = 7.0 \text{ mAdc},$ | t _{d(on)} | | 5.0 | ns |
| Rise Time | V _{GS(on)} = 0, V _{GS(off)} = -10 Vdc) (See Figure 1) | t _r | _ | 5.0 | ns |
| Turn-Off Delay Time | (V _{DD} = 10 Vdc, l _{D(on)} = 7.0 mAdc, | td(off) | | 15 | ns |
| Fall Time | VGS(on) = 0, VGS(off) = -10 Vdc) (See Figure 1) | tf | _ | 10 | ns |

^{*}Pulse Test: Pulse Width < 300 μs, Duty Cycle < 3.0%.

FIGURE 1 — SWITCHING TIMES TEST CIRCUIT



2N5638 2N5639 2N5640

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET SWITCHING

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|-------------|
| Drain-Source Voltage | VDS | 30 | Vdc |
| Drain-Gate Voltage | V _{DG} | 30 | Vdc |
| Reverse Gate-Source Voltage | VGSR | 30 | Vdc |
| Forward Gate Current | IGF | 10 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 310 2.82 | mW mW/°C |
| Junction Temperature Range | TJ | -65 to +150 | °C |
| Storage Temperature Range | T _{sta} | -65 to +150 | °C |

Refer to 2N5653 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|--|-----------------------|-----------------|---------------------------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage {I _G = 10 µAdc, V _{DS} = 0} | | V _(BR) GSS | 30 | | Vdc |
| Gate Reverse Current (VGS = -15 Vdc, VDS = 0) (VGS = -15 Vdc, VDS = 0, TA = 100°C) | | IGSS | _ | 1.0 1.0 | nAdc μAdc |
| Drain Cutoff Current (VDS = 15 Vdc, VGS = -12 Vdc) (VDS = 15 Vdc, VGS = -8.0 Vdc) (VDS = 15 Vdc, VGS = -6.0 Vdc) (VDS = 15 Vdc, VGS = -6.0 Vdc) (VDS = 15 Vdc, VGS = -12 Vdc, TA = 100°C) (VDS = 15 Vdc, VGS = -8.0 Vdc, TA = 100°C) (VDS = 15 Vdc, VGS = -6.0 Vdc, TA = 100°C) | 2N5638 2N5639 2N5640 2N5638 2N5639 2N5640 | ID(off) | | 1.0 1.0 1.0 1.0 1.0 | nAdc μAdc |
| ON CHARACTERISTICS | 2113040 | | | 1 1.0 | <u> </u> |
| Zero-Gate-Voltage Drain Current(1) (VDS = 20 Vdc, VGS = 0) | 2N5638 2N5639 2N5640 | ^I DSS | 50 25 5.0 | _ _ | mAdc |
| Drain-Source On-Voltage (I _D = 12 mAdc, V _{GS} = 0) (I _D = 6.0 mAdc, V _{GS} = 0) (I _D = 3.0 mAdc, V _{GS} = 0) | 2N5638 2N5639 2N5640 | VDS(on) | _ | 0.5 0.5 0.5 | Vdc |
| Static Drain-Source On Resistance (ID = 1.0 mAdc, VGS = 0) | 2N5638 2N5639 2N5640 | ^r DS(on) | 111 | 30 60 100 | Ohms |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Static Drain-Source "ON" Resistance (VGS = 0, I _D = 0, f = 1.0 kHz) | 2N5638 2N5639 2N5640 | ^r ds(on) | = | 30 60 100 | Ohms |
| Input Capacitance (Vps = 0, Vgs = -12 Vdc, f = 1.0 MHz) | | C _{iss} | | 10 | pF |
| Reverse Transfer Capacitance (VDS = 0, VGS = -12 Vdc, f = 1.0 MHz) | | C _{rss} | _ ~ | 4.0 | pF |

2N5638, 2N5639, 2N5640

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

| | Characterist | ic | | Symbol | Min | Max | Unit |
|---------------------------|---|--|----------------------------|---------------------|-----|-------------------|------|
| SWITCHING CHARACTERISTICS | | | | | | | |
| Turn-On Delay Time | | ID(on) = 12 mAdc 6.0 mAdc 3.0 mAdc | 2N5638 2N5639 2N5640 | ^t d(on) | | 4.0 6.0 8.0 | ns |
| Rise Time | V _{DD} = 10 Vdc, V _{GS(on)} = 0, | ID(on) = 12 mAdc 6.0 mAdc 3.0 mAdc | 2N5638 2N5639 2N5640 | t _r | _ | 5.0 8.0 10 | ns |
| Turn-Off Delay Time | $V_{GS(off)} = -10 \text{ Vdc},$ $R_{G'} = 50 \text{ ohms}$ | ID(on) = 12 mAdc 6.0 mAdc 3.0 mAdc | 2N5638 2N5639 2N5640 | ^t d(off) | | 5.0 10 15 | ns |
| Fall Time | | I _{D(on)} = 12 mAdc 6.0 mAdc 3.0 mAdc | 2N5638 2N5639 2N5640 | tf | - | 10 20 30 | ns |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 3.0%.

2N5653 2N5654

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET SWITCHING

N-CHANNEL -- DEPLETION

MAXIMUM RATINGS

| 110 0 0 111 11 11 11 11 11 11 11 11 11 1 | | | |
|---|------------------|-------------|-------------|
| Rating | Symbol | Value | Unit |
| Drain-Gate Voltage | V _{DG} | 30 | Vdc |
| Reverse Gate-Source Voltage | VGSR | 30 | Vdc |
| Forward Gate Current | l _{GF} | 10 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 310 2.82 | mW mW/°C |
| Storage Temperature Range | T _{sta} | -65 to +150 | °C |

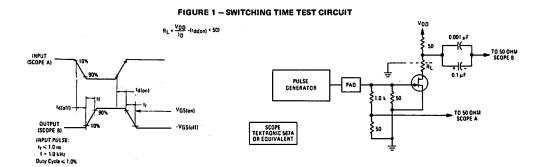
| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------------------------|-----------------------|--------------|--------------------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (IG = 10 µAdc, VDS = 0) | | V _(BR) GSS | 30 | _ | Vdc |
| Gate Reverse Current (VGS = -15 Vdc, VDS = 0) (VGS = -15 Vdc, VDS = 0, TA = 100°C) | | IGSS | = | 1.0 1.0 | nAdc μAdc |
| Drain Cutoff Current (V _{DS} = 15 Vdc, V _{GS} = −12 Vdc) (V _{DS} = 15 Vdc, V _{GS} = −8.0 Vdc) (V _{DS} = 15 Vdc, V _{GS} = −12 Vdc, T _A = 100°C) (V _{DS} = 15 Vdc, V _{GS} = −8.0 Vdc, T _A = 100°C) | 2N5653 2N5654 2N5653 2N5654 | ID(off) | - | 1.0 1.0 1.0 1.0 | nAdc μAdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current(1) (VDS = 20 Vdc, VGS = 0) | 2N5653 2N5654 | ^t oss | 40 15 | = | mAdc |
| Drain-Source On-Voltage (I _D = 10 mAdc, V _{GS} = 0) (I _D = 5.0 mAdc, V _{GS} = 0) | 2N5653 2N5654 | V _{DS(on)} | 11 | 0.75 0.75 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Static Drain-Source "ON" Resistance (VGS = 0, ID = 1.0 mAdc) | 2N5653 2N5654 | ^r ds(on) | = | 50 100 | Ohms |
| (VGS = 0, I _D = 0, f = 1.0 kHz) | 2N5653 2N5654 | | | 50 100 | |
| Input Capacitance (Vps = 0, Vgs = -12 Vdc, f = 1.0 MHz) | | C _{iss} | | 10 | pF |
| Reverse Transfer Capacitance (VDS = 0, VGS = -12 Vdc, f = 1.0 MHz) (VDS = 0, VGS = -8.0 Vdc, f = 1.0 MHz) | 2N5653 2N5653 | C _{rss} | = | 3.5 3.5 | pF |

2N5653, 2N5654

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| | Characteristic | | Symbol | Min | Max | Unit |
|---------------------|---|----------------------------|---------------------|--------------|------------|------|
| SWITCHING CHARACT | ERISTICS | | | | • | |
| Turn-On Delay Time | Test Condition for 2N5653: (VDD = 10 Vdc, VGS(on) = 0, VGS(off) = -12 Vdc, | 2N5653 2N5654 | ^t d(on) | _ | 4.0 6.0 | ns |
| Rise Time | t _{D(on)} = 10 mAdc, RG' = 50 Ohms) | 2N5653 2N5654 | t _r | _ | 5.0 8.0 | ns |
| Turn-Off Delay Time | Test Condition for 2N5654: (VDD = 10 Vdc, VGS(on) = 0, VGS(off) = -12 Vdc, ID(on) = 5.0 mAdc, | 2N5653 2N5654 2N5653 | ^t d(off) | - | 5.0 10 | ns |
| | Rg' = 50 Ohms) (Figure 1) | 2N5654 | tf | | 10 20 | ns |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 3.0%.



2N5668 2N5669 2N5670

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET VHF AMPLIFIER

N-CHANNEL - DEPLETION

MAXIMUM RATINGS

| MAXIMUM RATINGS | | | |
|---|------------------|-------------|-------------|
| Rating | Symbol | Value | Unit |
| Drain-Source Voltage | VDS | 25 | Vdc |
| Drain-Gate Voltage | V _{DG} | 25 | Vdc |
| Reverse Gate-Source Voltage | VGSR | 25 | Vdc |
| Drain Current | l _D | 20 | mAdc |
| Forward Gate Current | IG(f) | 10 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 310 2.82 | mW mW/°C |
| Storage Channel Temperature Range | T _{sto} | -65 to +150 | °C |

Min

Тур

Symbol

| ELECTRICAL CHARACTERISTICS (T _A = 25°C unless otherwise noted.) |
|--|
| Characteristic |

| Ottatablatio | | , -, | ****** | * 1 1 | ****** | |
|--|----------------------------|----------------------|----------------------|----------------|----------------------|--------------|
| OFF CHARACTERISTICS | | | | | | |
| Gate-Source Breakdown Voltage (I _G = 10 μAdc, V _{DS} = 0) | | V(BR)GSS | 25 | _ | _ | Vdc |
| Gate Reverse Current (V _G S = -15 Vdc, V _D S = 0) (V _G S = -15 Vdc, V _D S = 0, T _A = 100°C) | | IGSS | 1 1 | 1-1 | 2.0 2.0 | nAdc μAdc |
| Gate Source Cutoff Voltage (VDS = 15 Vdc, ID = 10 nAdc) | 2N5668 2N5669 2N5670 | VGS(off) | 0.2 1.0 2.0 | 1 1 1 | 4.0 6.0 8.0 | Vdc |
| ON CHARACTERISTICS | | | | | | |
| Zero-Gate-Voltage Drain Current(1) (V _{DS} = 15 Vdc, V _{GS} = 0) | 2N5668 2N5669 2N5670 | IDSS | 1.0 4.0 8.0 | _ | 5.0 10 20 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Forward Transfer Admittance (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz) | 2N5668 2N5669 2N5670 | Yfs | 1500 2000 3000 | = | 6500 6500 7500 | μmhos |
| Input Admittance (VDS = 15 Vdc, VGS = 0, f = 100 MHz) | | Re(yis) | _ | 125 | 800 | μmhos |
| Output Admittance (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz) | 2N5668 2N5669 2N5670 | İYosİ | = | = | 20 50 75 | μmhos |
| Output Conductance (VDS = 15 Vdc, VGS = 0, f = 100 MHz) | 2N5668 2N5669 2N5670 | Re(y _{OS}) | = | 10 25 35 | 50 100 150 | μmhos |
| Forward Transconductance (VDS = 15 Vdc, VGS = 0, f = 100 MHz) | 2N5668 2N5669 2N5670 | Re(yfs) | 1000 1600 2500 | - - | _ _ _ | μmhos |
| Input Capacitance (Vps = 15 Vdc, V _{GS} = 0, f = 1.0 MHz) | | C _{iss} | _ | 4.7 | 7.0 | pF |
| Reverse Transfer Capacitance (Vps = 15 Vdc, Vgs = 0, f = 1.0 MHz) | | C _{rss} | _ | 1.0 | 3.0 | pF |

Unit

Max

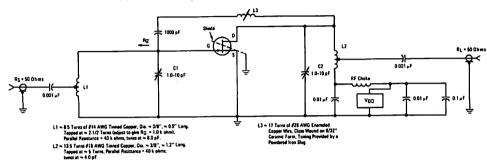
2N5668, 2N5669, 2N5670

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|--------|-----|-----|-----|------|
| Output Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz) | Coss | | 1.4 | 4.0 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | | |
| Noise Figure (Figure 1) (VDS = 15 Vdc, VGS = 0, f = 100 MHz at RG' = 1.0 k ohm) | NF | _ | - | 2.5 | dB |
| Common Source Power Gain (Figure 1) (VDS = 15 Vdc, VGS = 0, f = 100 MHz) | Gps | 16 | _ | _ | dB |

⁽¹⁾ Pulse Test: Pulse Width = 100 ms, Duty Cycle ≤ 10%.

FIGURE 1 - 100 MHz, POWER GAIN AND NOISE FIGURE TEST CIRCUIT



2N6659 2N6660 2N6661 MPF6659 MPF6660 MPF6661

2N6659,60,61 CASE 79-02, STYLE 6 TO-39 (TO-205AD) MPF6659,60,61

TO-226AE

TMOS SWITCHING TRANSISTOR

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

| Rating | Symbol | 2N6659 MPF6659 | 2N6660 MPF6660 | 2N6661 MPF6661 | Unit |
|--|-----------------------------------|--|-------------------|-------------------|----------------|
| Drain-Source Voltage | VDS | 35 | 60 | 90 | Vdc |
| Drain-Gate Voltage | VDG | 35 | 60 | 60 90 | |
| Gate-Source Voltage | VGS | | Vdc | | |
| Drain Current — Continuous (1) Pulsed (2) | I _D | | Adc | | |
| | | 2N6659 MPF6659 2N8660 MPF6660 2N6661 MPF6661 | | _ | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 6.25 50 | | 2.5 20 | Watts mW/°C |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | _ | | 1.0 8.0 | |
| Operating and Storage Junction Temperature Range | T _J , T _{Stg} | | 55 to +15 | 50 | ပ္ |

- (1) The Power Dissipation of the package may result in a lower continuous drain current.
- (2) Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|---|---------------------|----------------|-------------------|-------------------|-------|
| OFF CHARACTERISTICS | | | | | | |
| Zero-Gate-Voltage Drain Current (VDS = Maximum Rating, VGS = 0) | | IDSS | _ | _ | 10 | μAdc |
| Gate-Body Leakage Current (VGS = 15 V, VDS = 0) | | IGSS | - | | 100 | nAdc |
| Drain-Source Breakdown Voltage (VGS = 0, I _D = 10 μA) | 2N6659, MPF6659 2N6660, MPF6660 2N6661, MPF6661 | V(BR)DSX | 35 60 90 | | _ _ _ | Vdc |
| ON CHARACTERISTICS(1) | | | | | | |
| Gate Threshold Voltage (VDS = VGS, ID = 1.0 mA) | | VGS(Th) | 0.8 | 1.4 | 2.0 | Vdc |
| Drain-Source On-Voltage (VGS = 10 V, I _D = 1.0 A) | 2N6659, MPF6659 2N6660, MPF6660 2N6661, MPF6661 | V _{DS(on)} | _ _ _ | _ _ _ | 1.8 3.0 4.0 | Vdc |
| $(V_{GS} = 5.0 \text{ V}, I_{D} = 0.3 \text{ A})$ | 2N6659, MPF6659 2N6660, MPF6660 2N6661, MPF6661 | | _ | 0.8 0.9 0.9 | 1.5 1.5 1.6 | } |
| Static Drain-Source On Resistance (VGS = 10 Vdc, ID = 1.0 Adc) | 2N6659, MPF6659 2N6660, MPF6660 2N6661, MPF6661 | rDS(on) | _ _ _ | _ _ _ | 1.8 3.0 4.0 | Ohms |
| On-State Drain Current (VDS = 25 V, VGS = 10 V) | | I _{D(on)} | 1.0 | 2.0 | _ | Amps |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Input Capacitance (VDS = 25 V, VGS = 0, f = 1.0 MHz) | | C _{iss} | _ | 30 | 50 | pF |
| Reverse Transfer Capacitance (VDS = 25 V, VGS = 0, f = 1.0 MHz) | | Crss | _ | 3.6 | 10 | ρF |
| Output Capacitance (VDS = 25 V, VGS = 0, f = 1.0 MHz) | | Coss | | 20 | 40 | рF |
| Forward Transconductance (VDS = 25 V, ID = 0.5 A) | | 9fs | 170 | _ | | mmhos |

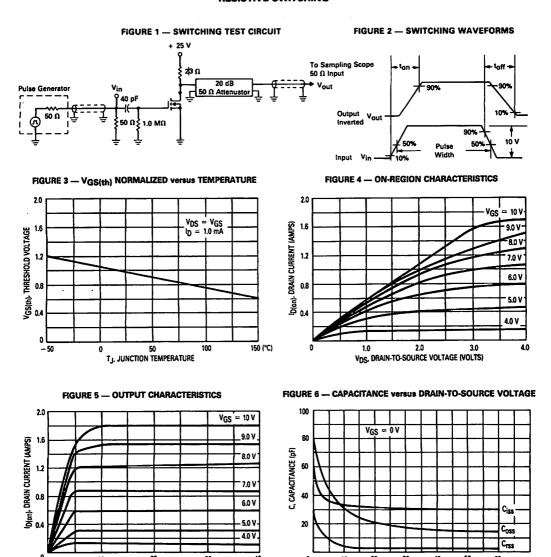
2N6659, 2N6660, 2N6661, MPF6659, MPF6660, MPF6661

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|------------------------------|------------|-----|-----|-----|------|
| SWITCHING CHARACTERISTICS(1) | | | | | |
| Rise Time | tr | _ | | 5.0 | ns |
| Fall Time | tf | _ | _ | 5.0 | ns |
| Turn-On Time | ton | _ | _ | 5.0 | ns |
| Turn-Off Time | toff | _ | _ | 5.0 | ns |

⁽¹⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

RESISTIVE SWITCHING

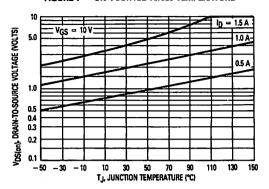


VDS, DRAIN-TO-SOURCE VOLTAGE (VOLTS)

VDS, DRAIN-TO-SOURCE VOLTAGE (VOLTS)

2N6659, 2N6660, 2N6661, MPF6659, MPF6660, MPF6661

FIGURE 7 — ON-VOLTAGE versus TEMPERATURE



3N128

CASE 20-03, STYLE 7 TO-72 (TO-206AF)

MOSFET AMPLIFIER

N-CHANNEL - DEPLETION

MAXIMUM RATINGS

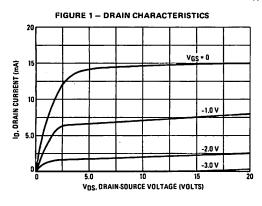
| Rating | Symbol | Value | Unit |
|---|----------------------|-------------|-------------|
| Drain-Source Voltage | VDS | +20 | Vdc |
| Drain-Gate Voltage | V _{DG} | +20 | Vdc |
| Gate-Source Voltage | VGS | ±10 | Vdc |
| Drain Current | اوا | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 330 2.2 | mW mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +175 | °C |

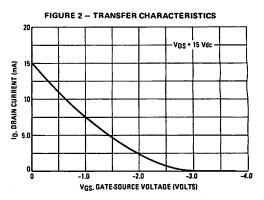
| Characteristic | Symbol | Min | Max | Unit |
|--|----------------------|------|-------------|-------|
| OFF CHARACTERISTICS | | | | |
| Gate-Source Breakdown Voltage(1) (IG = -10 μAdc, VDS = 0) | V(BR)GSS | -50 | _ | Vdc |
| Gate Reverse Current (VGS = -8.0 Vdc, V _{DS} = 0) (VGS = -8.0 Vdc, V _{DS} = 0, T _A = 125°C) | lgss | = | 0.05 5.0 | nAdc |
| Gate Source Cutoff Voltage ($V_{DS} = 15 \text{ Vdc}, I_{D} = 50 \mu \text{Adc}$) | VGS(off) | -0.5 | -8.0 | Vdc |
| ON CHARACTERISTICS | | | | |
| Zero-Gate-Voltage Drain Current(2) (VDS = 15 Vdc, VGS = 0) | IDSS | 5.0 | 25 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Forward Transfer Admittance (VDS = 15 Vdc, lD = 5.0 mAdc, f = 1.0 kHz) | Y _{fs} | 5000 | 12,000 | μmhos |
| Input Admittance (VDS = 15 Vdc, ID = 5.0 mAdc, f = 200 MHz) | Re(y _{is}) | _ | 800 | μmhos |
| Output Conductance (VDS = 15 Vdc, ID = 5.0 mAdc, f = 200 MHz) | Re(y _{os}) | _ | 500 | μmhos |
| Forward Transconductance {V _{DS} = 15 Vdc, I _D = 5.0 mAdc, f = 200 MHz} | Re(y _{fs}) | 5000 | - | μmhos |
| Input Capacitance (V _{DS} = 15 Vdc, I _D = 5.0 mAdc, f = 1.0 MHz) | C _{iss} | _ | 7.0 | pF |
| Reverse Transfer Capacitance (VDS = 15 Vdc, ID = 5.0 mAdc, f = 1.0 MHz) | C _{rss} | 0.05 | 0.35 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | |
| Noise Figure (V _{DS} = 15 Vdc, I _D = 5.0 mAdc, f = 200 MHz) | NF | | 5.0 | dB |
| Power Gein {V _{DS} = 15 Vdc, I _D = 5.0 mAdc, f = 200 MHz} | PG | 13.5 | 23 | dB |
| Caution Destructive Test, can demand gate oxide beyond operation | | | | |

⁽¹⁾ Caution Destructive Test, can damage gate oxide beyond operation.

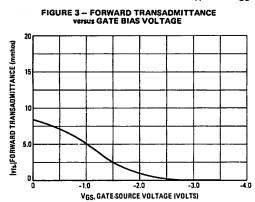
⁽²⁾ Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

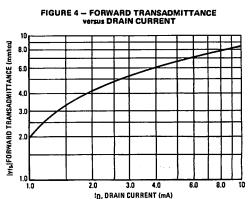
TYPICAL CHARACTERISTICS (TA = 25°C)



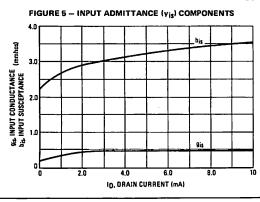


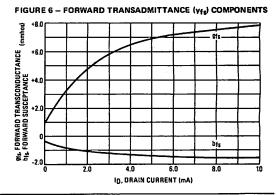
TYPICAL 1 kHz DRAIN CHARACTERISTICS (TA = 25°C, VDS = 15 Vdc, f = 1.0 kHz)



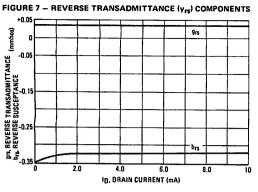


TYPICAL 200 MHz COMMON-SOURCE ADMITTANCE CHARACTERISTICS ($T_A = 25^{\circ}C$, $V_{DS} = 15 \text{ Vdc}$, f = 200 MHz)





SMALL-SIGNAL DEVICES



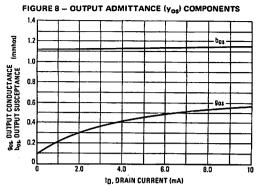


FIGURE 9 - POWER GAIN AND NOISE FIGURE

24 | 1 - 200 MHz | PG | R. 0 | St. T | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0 | R. 0

FIGURE 10 – POWER GAIN AND NOISE FIGURE
VETSUS DRAIN VOLTAGE

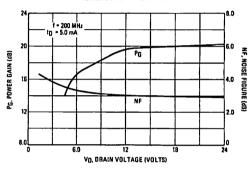


FIGURE 11 - THIRD ORDER INTERMODULATION DISTORTION

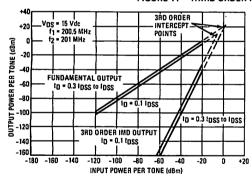
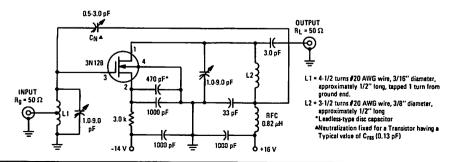


Figure 11 shows the typical third order intermodulation distortion (IMD) performance of the 3N128 at 200 MHz.

Both fundamental output and third order IMD output characteristics are plotted. The curves have been extrapolated to show the third order intermodulation output intercept point.

Performance for drain currents from IDSS to 0.1 IDSS, is given. The power gain and noise figure test amplifier shown in Figure 12 was used to generate the IMD data.

FIGURE 12 - POWER GAIN, NOISE FIGURE AND INTERMODULATION DISTORTION TEST CIRCUIT



3N155 3N156

CASE 20-03, STYLE 2 TO-72 (TO-206AF)

MOSFET SWITCHING

P-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|------------------|-------------|-------------|
| Drain-Source Voltage | VDS | ±35 | Vdc |
| Drain-Gate Voltage | V _{DG} | ±50 | Vdc |
| Gate-Source Voltage | VGS | ± 50 | Vdc |
| Drain Current | l _D | 30 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 2.0 | mW mW/°C |
| Junction Temperature Range | TJ | -65 to +175 | °C |
| Storage Channel Temperature Range | T _{stg} | -65 to +175 | °C |

Refer to 3N157 for graphs.

| | Characteristic | Symbol | Min | Тур | Max | Unit |
|---|--|---------------------|-----------|------------|-----------------|-------|
| OFF CHARACTERISTICS | | | | | | |
| Drain-Source Breakdown | Voltage (I _D = -10 μAdc, V _G = V _S = 0) | V(BR)DSX | -35 | _ _ | - | Vdc |
| Zero-Gate-Voltage Drain C | Current (VDS = -10 Vdc, VGS = 0) (VDS = -10 Vdc, VGS = 0, TA = 125°C) | IDSS | | 1 | - 1.0 - 1000 | nAdc |
| Gate Reverse Current (V | GS = +50 Vdc, V _{DS} = 0) GS = +25 Vdc, V _{DS} = 0) | IGSS | | 1 1 | + 1000 + 10 | pAdc |
| Resistance Drain Source | (ID = 0, VGS = 0) | fDS(off) | 1 x 10+10 | 1 | _ | Ohms |
| Resistance Gate Source In | nput (VGS = -25 Vdc) | RGS | _ | 1 x 10+16 | - | Ohms |
| Gate Forward Leakage Cu | rrent (VGS = -50 Vdc, VDS = 0) (VGS = -25 Vdc, VDS = 0) | lG(f) | | 1 - | - 1000 - 10 | pAdc |
| ON CHARACTERISTICS | | | | | | |
| Gate Threshold Voltage | $(V_{DS} = -10 \text{ Vdc}, I_{D} = -10 \mu \text{Adc})$ | VGS(Th) | - 1.5 | _ | -3.2 | Vdc |
| Drain-Source On-Voltage | $(!_{D} = -2.0 \text{ mAdc, V}_{GS} = -10 \text{ Vdc})$ | V _{DS(on)} | _ | _ | - 1.0 | Vdc |
| Static Drain-Source On Re | esistance (ID = 0 mAdc, VGS = -10 Vdc) | rDS(on) | | _ | 600 | Ohms |
| | V _{DS} = -15 Vdc, V _{GS} = -10 Vdc) | ID(on) | - 5.0 | | _ | mAdc |
| SMALL-SIGNAL CHARAC | TERISTICS | | | | | |
| Orain-Source Resistance (VGS = -10 Vdc, ID = (VGS = -15 Vdc, ID = | | ^r ds(on) | _ | _ | 400 350 | Ohms |
| Forward Transfer Admitta (VDS = -15 Vdc, ID = | nce -2.0 mAdc, f = 1.0 kHz) | Yfs | 1000 | _ | 4000 | μmhos |
| Input Capacitance | = -10 Vdc, f = 140 kHz) | C _{iss} | _ | _ | 5.0 | pF |
| Reverse Transfer Capacita (VDS = 0, VGS = 0, f | ance | C _{rss} | _ | _ | 1.3 | pF |
| Drain-Substrate Capacitae (VD(SUB) = -10 Vdc, | | C _{d(sub)} | 4.0 | | _ | pF |
| SWITCHING CHARACTE | | | | | | |
| Turn-On Delay | | t _d | <u> </u> | <u> </u> | 45 | μѕ |
| Rise Time | (V _{DD} = -10 Vdc, I _{D(on)} = -2.0 mAdc, | t _r | | | 65 | ns |
| Turn-Off Delay | VGS(on) = -10 Vdc, VGS(off) = 0) | tg | | <u> </u> | 60 | ns |
| Fall Time | | tf | | | 100 | ns |

3N157 3N158

CASE 20-03, STYLE 2 TO-72 (TO-206AF)

MOSFET AMPLIFIER AND SWITCHING

P-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|-------------|
| Drain-Source Voltage* | VDS | ±35 | Vdc |
| Drain-Gate Voltage* | VDG | ±50 | Vdc |
| Gate-Source Voltage* | VGS | ±50 | Vdc |
| Drain Current* | ľD | 30 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C* | PD | 300 1.7 | mW mW/°C |
| Junction Temperature Range* | TJ | -65 to +175 | °C |
| Storage Channel Temperature Range* | T _{stg} | -65 to +175 | ° |

^{*}JEDEC Registered Limits

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|---------------------|----------------|------------------|--------------------------------|------------------------------|
| OFF CHARACTERISTICS | | | | | |
| Drain-Source Breakdown Voltage (I _D = -10 μAdc, V _G = V _S = 0) | V(BR)DSX | -35 | - | _ | Vdc |
| Zero-Gate-Voltage Drain Current $(V_{DS} = -15 \text{ Vdc}, V_{GS} = 0)$ $(V_{DS} = -35 \text{ Vdc}, V_{GS} = 0)$ | IDSS | _ | _ | 1.0 10 | nAdc µAdc |
| Gate Reverse Current* (V _{GS} = +25 Vdc, V _{DS} = 0) (V _{GS} = +50 Vdc, V _{DS} = 0) | IGSS | _ | _ | + 10 + 10 | pAdc nAdc |
| Input Resistance (VGS = -25 Vdc) | RGS | | 1 x 10+12 | _ | Ohms |
| Gate Source Voltage* (Vps = -15 Vdc, Ip = -0.5 mAdc) 3N157 3N158 | V _{GS} | - 1.5 - 3.0 | - | - 5.5 - 7.0 | Vdc |
| Gate Forward Current* (VGS = -25 Vdc, V _{DS} = 0) (VGS = -50 Vdc, V _{DS} = 0) (VGS = -25 Vdc, V _{DS} = 0, T _A = +55°C) (VGS = -50 Vdc, V _{DS} = 0, T _A = +55°C) | lG(f) | = = | _ _ _ _ | - 10 - 1.0 - 10 - 1.0 | pAdc nAdc nAdc μAdc |
| Gate Threshold Voltage* (VDS = -15 Vdc, ID = -10 μAdc) 3N157 3N158 | V _{GS(Th)} | - 1.5 - 3.0 | _ | - 3.2 - 5.0 | Vdc |
| On-State Drain Current* (Vps = -15 Vdc, Vgs = -10 Vdc) | [[] D(on) | -5.0 | _ | _ | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | • | | | | |
| Forward Transfer Admittance* (Vps = -15 Vdc, lp = -2.0 mAdc, f = 1.0 kHz) | lyfsl | 1000 | _ | 4000 | μmhos |
| Output Admittance* (VDS = -15 Vdc, ID = -2.0 mAdc, f = 1.0 kHz) | lyosl | _ | _ | 60 | μmhos |
| Input Capacitance* $(VDS = -15 \text{ Vdc}, VGS = 0, f = 140 \text{ kHz})$ | C _{iss} | - | _ | 5.0 | рF |
| Reverse Transfer Capacitance* (VDS = -15 Vdc, VGS = 0, f = 140 kHz) | C _{rss} | - | _ | 1.3 | pF |
| Drain-Substrate Capacitance (VD(SUB) = -10 Vdc, f = 140 kHz) | C _{d(sub)} | | _ | 4.0 | pF |
| Noise Voltage (Rg = 0, BW = 1.0 Hz, VDS = -15 Vdc, ID = -2.0 mAdc, f = 100 Hz) | en | _ | 300 | _ | NV/√Hz |
| (R _S = 0, BW = 1.0 Hz, V _{DS} = -15 Vdc, I _D = -2.0 mAdc, f = 1.0 kHz) | | <u> </u> | 120 | 500 | |

^{*}JEDEC Registered Limits

FIGURE 1 - FORWARD TRANSCONDUCTANCE

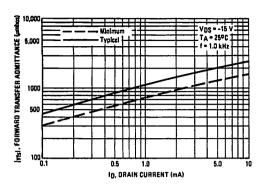


FIGURE 2 - OUTPUT TRANSCONDUCTANCE

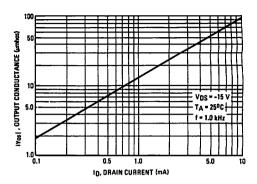


FIGURE 3 - FORWARD TRANSCONDUCTANCE

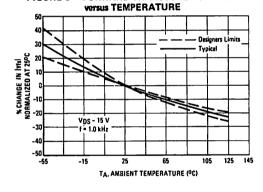


FIGURE 4 - BIAS CURVE

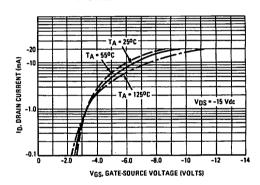


FIGURE 5 - "ON" DRAIN-SOURCE VOLTAGE

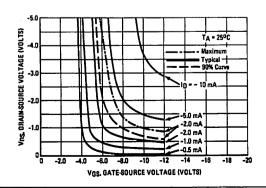
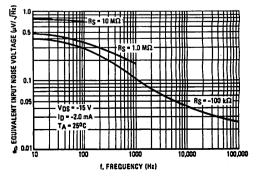


FIGURE 6 - EQUIVALENT INPUT NOISE VOLTAGE



SWITCHING CHARACTERISTICS

 $(T_{\Delta} = 25^{\circ}C)$

FIGURE 7 - TURN-ON DELAY TIME

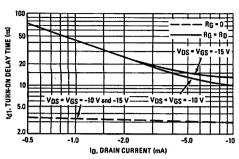


FIGURE 8 - RISE TIME

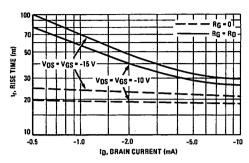


FIGURE 9 - TURN-OFF DELAY TIME

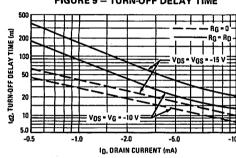


FIGURE 10 - FALL TIME

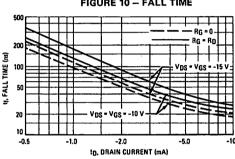
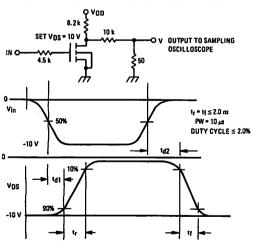


FIGURE 11 - SWITCHING CIRCUIT and WAVEFORMS



The switching characteristics shown above were measured in a test circuit similar to Figure 11. At the beginning of the switching interval, the gate voltage is at ground and the gate source capacitance (C $_{\rm ISS}$ * C $_{\rm ISS}$ * C $_{\rm ISS}$) has no charge. The drain voltage is at V $_{\rm DD}$ and thus the feedback capacitance (C $_{\rm ISS}$) is charged to VDD. Similarly, the drain substrate capacitance (Cd(sub)) is charged to VDD since the substrate and source are connected to ground.

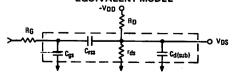
During the turn-on interval C_{gs} is charged to V_{GS} (the input voltage) through R_G (generator impedance) (Figure 12). C_{rss} must be discharged to VGS . VD(on) through RG and the parallel combination of the load resistor (RD) and the channel resistance (r_{ds}). In addition, $C_{d(sub)}$ is discharged to a low value ($V_{D(on)}$) through R_D in parallel with r_{ds} . During turn-off this charge flow is reversed.

Predicting turn-on time proves to be somewhat difficult since the channel resistance (rds) is a function of the gate source voltage (VGS). As C_{gs} becomes charged VGS is approaching V_{in} and r_{ds} decreases (see Figure 5) and since C_{rss} and $C_{d(sub)}$ are charged through rds, turn-on time is quite non-linear.

If the charging time of C_{gs} is short compared to that of C_{rss} and Cd(sub), then rds (which is in parallel with RD) will be low compared to RD during the switching interval and will largely determine the turn-on time. On the other hand, during turnoff rds will be almost an open circuit requiring Crss and Cd(sub) to be charged through RD and resulting in a turn-off time that is long compared to the turn-on time. This is especially noticeable for the curves where RG • 0 and Cqs is charged through the pulse generator impedance only.

The switching curves shown with Rg • RD simulate the switching behavior of cascaded stages where the driving source impedance is normally the same as the load impedance. The set of curves with Rg • 0 simulates a low source impedance drive such as might occur in complementary logic circuits.

FIGURE 12 - SWITCHING CIRCUIT with MOSFET **EQUIVALENT MODEL**



3N169 3N170 3N171

CASE 20-03, STYLE 2 TO-72 (TO-206AF)

MOSFET SWITCHING

N-CHANNEL -- ENHANCEMENT

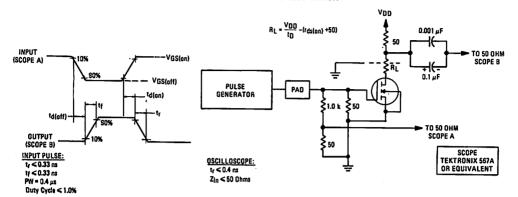
MAXIMUM RATINGS

| MAXIMUM RATINGS | , | | |
|---|------------------|-------------|-------------|
| Rating | Symbol | Value | Unit |
| Drain-Source Voltage | V _{DS} | 25 | Vdc |
| Drain-Gate Voltage | V _{DG} | ±35 | Vdc |
| Gate-Source Voltage | VGS | ±35 | Vdc |
| Drain Current | l _D | 30 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 1.7 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 800 4.56 | mW mW/°C |
| Junction Temperature Range | TJ | 175 | °C |
| Storage Temperature Range | T _{stg} | -65 to +175 | ·c |

Refer to 2N4351 for graphs.

| | Characteristic | Symbol | Min | Max | Unit |
|--|---|---------------------|-------------------|-------------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Drain-Source Breakdown (ID = 10 μAdc, VGS = | | V(BR)DSX | 25 | _ | Vdc |
| Zero-Gate-Voltage Drain (VDS = 10 Vdc, VGS = (VDS = 10 Vdc, VGS = | • 0) | IDSS | _ | 10 1.0 | nAdc μAdc |
| Gate Reverse Current (VGS = -35 Vdc, VDS (VGS = -35 Vdc, VDS | | IGSS | = | 10 100 | pAdc |
| ON CHARACTERISTICS | | | | | |
| Gate Threshold Voltage (VDS = 10 Vdc, ID = 1 | 0 μAdc) 3N169 3N170 3N171 | VGS(Th) | 0.5 1.0 1.5 | 1.5 2.0 3.0 | Vdc |
| Drain-Source On-Voltage (ID = 10 mAdc, VGS = | 10 Vdc) | V _{DS(on)} | | 2.0 | Vdc |
| On-State Drain Current (VGS = 10 Vdc, VDS = | | lD(on) | 10 | _ | mAdc |
| SMALL-SIGNAL CHARAC | TERISTICS | | | | |
| Orain-Source Resistance (VGS = 10 Vdc, ID = 0 |), f = 1.0 kHz) | rds(on) | - | 200 | Ohms |
| Forward Transfer Admitta (Vps = 10 Vdc, lp = 2 | ** · · · · · | lyfsl | 1000 | _ | μmhos |
| Input Capacitance (Vps = 10 Vdc, Vgs = | · 0, f = 1.0 MHz) | C _{iss} | _ | 5.0 | ρF |
| Reverse Transfer Capacit (Vps = 0, Vgs = 0, f | | C _{rss} | _ | 1.3 | pF |
| Drain-Substrate Capacita (VD(SUB) = 10 Vdc, f | | C _{d(sub)} | _ | 5.0 | pF |
| SWITCHING CHARACTE | RISTICS | | | | |
| Turn-On Delay Time | Was - 10 Vds lat 1 - 10 mAds | td(on) | | 3.0 | ns |
| Rise Time | (V _{DD} = 10 Vdc, I _{D(on)} = 10 mAdc, V _{GS(on)} = 10 Vdc, V _{GS(off)} = 0, | t _r | _ | 10 | ns |
| Turn-Off Delay Time | Rg' = 50 Ohms) | td(off) | _ | 3.0 | ns |
| Fall Time | See Figure 1 | tf | _ | 15 | ns |

FIGURE 1 — SWITCHING TIME TEST CIRCUIT



3N201 3N202 3N203

CASE 20-03, STYLE 9 TO-72 (TO-206AF)

DUAL-GATE MOSFET VHF AMPLIFIER

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

| Rating Symbol | | Value | Unit |
|---|--------------------------------------|-------------|--------------|
| Drain-Source Voltage | V _{DS} 25 | | Vdc |
| Drain-Gate Voltage | V _{DG1} V _{DG2} | 30 30 | Vdc |
| Drain Current | ۵ا | 50 | mAdc |
| Gate Current | IG1 IG2 | ±10 ±10 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 360 2.4 | mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 8.0 | Watt mW/℃ |
| Lead Temperature | TL | 300 | •€ |
| Junction Temperature Range | Tj | -65 to +175 | °C |
| Storage Channel Temperature Range | T _{stg} | -65 to +175 | °C |

Refer to MPF201 for additional graphs.

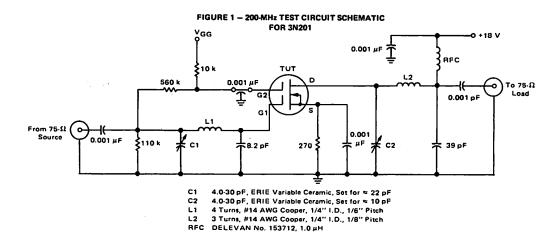
| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|----------------------|-------------------|--------------|--------------|---------------|--------------|
| OFF CHARACTERISTICS | | | | | | |
| Drain-Source Breakdown Voltage (Ip = 10 µAdc, Vs = 0, Vg1s = Vg2s = -5.0 Vdc) | | V(BR)DSX | 25 | _ | | Vdc |
| Gate 1-Source Breakdown Voltage(1) (IG1 = ±10 mAdc, VG2S = VDS = 0) | | V(BR)G1SO | ± 6.0 | ±12 | ±30 | Vdc |
| Gate 2-Source Breakdown Voltage(1) (I _{G2} = ±10 mAdc, V _{G1S} = V _{DS} = 0) | | V(BR)G2SO | ±6.0 | ±12 | ±30 | Vdc |
| Gate 1 Leakage Current (VG1S = ±5.0 Vdc, VG2S = VDS = 0) (VG1S = -5.0 Vdc, VG2S = VDS = 0, TA = 150°C) | | I _{G1SS} | | .±.040 | ± 10 - 10 | nAdc µAdc |
| Gate 2 Leakage Current (VG2S = ±5.0 Vdc, VG1S = VDS = 0) (VG2S = -5.0 Vdc, VG1S = VDS = 0, TA = 150°C) | | l _{G2SS} | - | ±.050 — | ± 10 - 10 | nAdc μAdc |
| Gate 1 to Source Cutoff Voltage (V _{DS} = 15 Vdc, V _{G2S} = 4.0 Vdc, I _D = 20 μAdc) | | VG1S(off) | -0.5 | - 1.5 | -5.0 | Vdc |
| Gate 2 to Source Cutoff Voltage (VDS = 15 Vdc, VG1S = 0, ID = 20 µAdc) | | VG2S(off) | -0.2 | -1.4 | - 5.0 | Vdc |
| ON CHARACTERISTICS | | | | | | |
| Zero-Gate-Voltage Drain Current(2) (VDS = 15 Vdc, VG1S = 0, VG2S = 4.0 Vdc) | 3N201,3N202 3N203 | loss | 6.0 3.0 | 13 11 | 30 15 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Forward Transfer Admittance(3) (VDS = 15 Vdc, VG2S = 4.0 Vdc, VG1S = 0, $f = 1.0 \text{ kHz}$) | 3N201,3N202 3N203 | Y _{fs} | 8.0 7.0 | 12.8 12.5 | 20 15 | mmhos |
| Input Capacitance (Vps = 15 Vdc, Vg2s = 4.0 Vdc, Ip = Ipss, f = 1.0 MHz) | | Ciss | _ | 3.3 | _ | pF |
| Reverse Transfer Capacitance (Vps = 15 Vdc, Vg2s = 4.0 Vdc, Ip = 10 mAdc, f = 1.0 M | lHz) | C _{rss} | 0.005 | 0.014 | 0.03 | pF |
| Output Capacitance (Vps = 15 Vdc, V_{G2S} = 4.0 Vdc, V_{D} = V_{DSS} , V_{DSS} , V_{DSS} = 1.0 MHz) | | Coss | _ | 1.7 | | pF |
| FUNCTIONAL CHARACTERISTICS | | | | | - | |
| Noise Figure (VDD = 18 Vdc, VGG = 7.0 Vdc, f = 200 MHz) (Figure 1) (VDD = 18 Vdc, VGG = 6.0 Vdc, f = 45 MHz) (Figure 3) | 3N201 3N203 | NF | <u> </u> | 1.8 5.3 | 4.5 6.0 | dB |

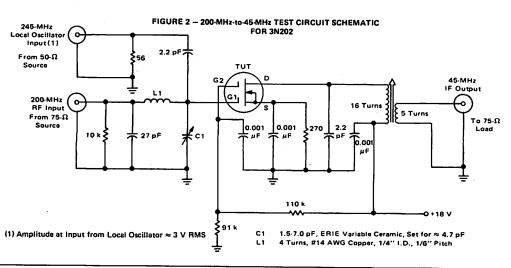
3N201, 3N202, 3N203

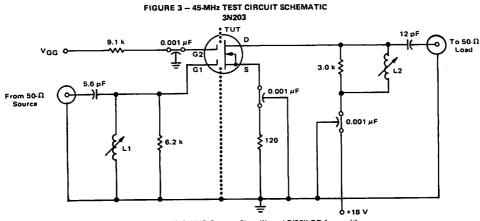
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|-------|---------------------|-----|------------|------|-------|
| Common Source Power Gain | | Gps | | | | dB |
| (VDD = 18 Vdc, VGG = 7.0 Vdc, f = 200 MHz) (Figure 1) | 3N201 | | 15 | 20 | 25 | |
| (V _{DD} = 18 Vdc, V _{GG} = 6.0 Vdc, f = 45 MHz) (Figure 3) | 3N203 | | 20 | 25 | 30 | |
| (V _{DD} = 18 Vdc, f _{LO} = 245 MHz, f _{RF} = 200 MHz) (Figure 2) | 3N202 | G _c (5) | 15 | 19 | 25 | |
| Bandwidth | | BW | | | | MHz |
| (VDD = 18 Vdc, VGG = 7.0 Vdc, f = 200 MHz) (Figure 1) | 3N201 | İ | 5.0 | 1 _ : | 9.0 | |
| (VDD = 18 Vdc, fLO = 245 MHz, fRF = 200 MHz) (Figure 2) | 3N202 | j | 4.5 | l <u> </u> | 7.5 | |
| (V _{DD} = 18 Vdc, V _{GG} = 6.0 Vdc, f = 45 MHz) (Figure 3) | 3N203 | | 3.0 | - | 6.0 | |
| Gain Control Gate-Supply Voltage(4) | | V _{GG(GC)} | | | | Vdc |
| $(V_{DD} = 18 \text{ Vdc}, \Delta G_{DS} = -30 \text{ dB}, f = 200 \text{ MHz}) \text{ (Figure 1)}$ | 3N201 | 55,66, | 0 | - 1.0 | -3.0 | ,,,,, |
| $(V_{DD} = 18 \text{ Vdc}, \Delta G_{DS} = -30 \text{ dB}, f = 45 \text{ MHz}) \text{ (Figure 3)}$ | 3N203 | | 0 | -0.6 | -3.0 | |

- (1) All gate breakdown voltages are measured while the device is conducting rated gate current. This ensures that the gate-voltage limiting network is functioning properly.
- (2) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2.0%.
- (3) This parameter must be measured with bias voltages applied for less than 5 seconds to avoid overheating.
- (4) ΔGps is defined as the change in Gps from the value at VGG = 7.0 volts (3N201) and VGG = 6.0 volts (3N203).
- (5) Power Gain Conversion

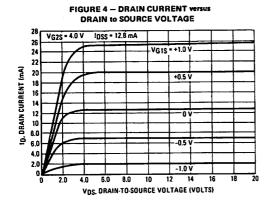


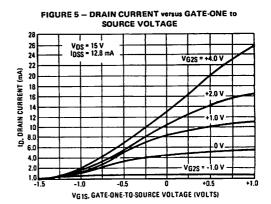


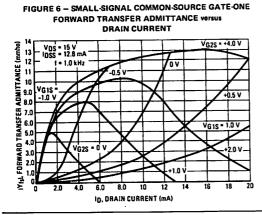


- L1 14 Turns, #30 AWG Copper, Close-Wound 7/32" OD form with ARNOLD ENGINEERING "J" Tuning Core
- L2 10 Turns, #30 AWG Copper, Close-Wound 7/32" OD form with ARNOLD ENGINEERING "J" Tuning Core

TYPICAL CHARACTERISTICS







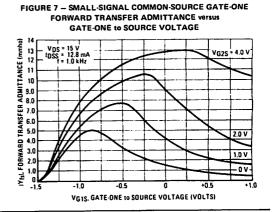


FIGURE 8 – SMALL-SIGNAL COMMON-SOURCE GATE-ONE
FORWARD TRANSFER ADMITTANCE VISUS
GATE-TWO to SOURCE VOLTAGE

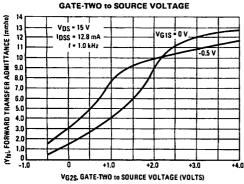
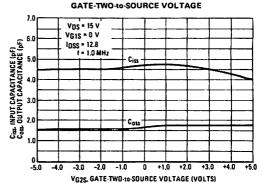


FIGURE 9 — SMALL-SIGNAL COMMON-SOURCE GATE-ONE INPUT AND OUTPUT CAPACITANCE versus



TYPICAL CHARACTERISTICS

FIGURE 10 – COMMON-SOURCE POWER GAIN AND SPOT NOISE FIGURE WITSUS DRAIN CURRENT

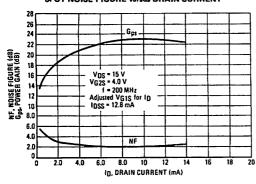


FIGURE 11 – COMMON-SOURCE POWER GAIN AND SPOT NOISE FIGURE VOTEUS GAIN CONTROL

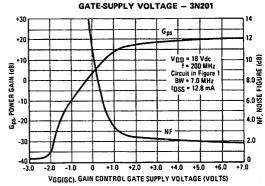


FIGURE 12 - COMMON-SOURCE POWER GAIN

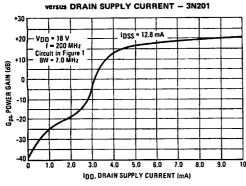


FIGURE 13 – SMALL-SIGNAL COMMON-SOURCE
CONVERSION POWER GAIN versus

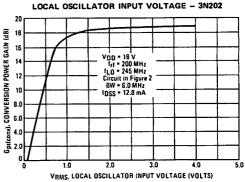
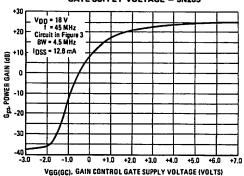


FIGURE 14 — SMALL-SIGNAL COMMON SOURCE INSERTION POWER GAIN VERSUS GAIN CONTROL GATE-SUPPLY VOLTAGE — 3N203



TYPICAL CHARACTERISTICS

FIGURE 15 - SMALL-SIGNAL GATE ONE FORWARD

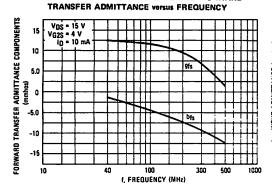


FIGURE 16 - SMALL-SIGNAL GATE ONE INPUT ADMITTANCE versus FREQUENCY

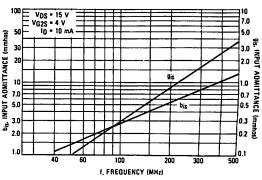
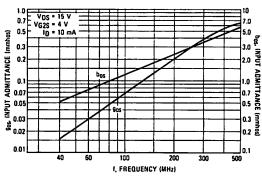


FIGURE 17 — SMALL-SIGNAL GATE ONE OUTPUT ADMITTANCE versus FREQUENCY



MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|----------------------|----------------------|-------------|
| Drain-Source Voltage | V _{DS} | 25 | Vdc |
| Drain-Gate Voltage | V _{DG} | 30 | Vdc |
| Drain Current | l _D | 50 | mA |
| Reverse Gate Current | ij | - 10 | mA |
| Forward Gate Current | IGF | 10 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 360 2.4 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 0.8 | mW mW/°C |
| Lead Temperature | TL | 300 | •c |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | - 65°C to + 175°C | °C |

3N204 3N205

CASE 20-03, STYLE 9 TO-72 (TO-206AF)

> DUAL GATE MOS-FET

N-CHANNEL - DEPLETION

| Characteristic | | Symbol | Min | Max | Unit |
|--|----------------|-------------------|----------|------------|-------|
| OFF CHARACTERISTICS | | | | | |
| Drain-Source Breakdown Voltage (I _D = 10 µA, V _{G1} = V _{G2} = -5.0 V) | | V(BR)DSX | 25 | | Vdc |
| Gate 1-Source Breakdown Voltage (I _{G1} = ±10 mA) Note 1 | | V(BR)G1SO | ±6 | ±30 | Vdc |
| Gate 2-Source Breakdown Voltage (IG2 = ±10 mA) Note 1 | | V(BR)G2SO | ±6 | ±30 | Vdc |
| Gate 1 Leakage Current (VG1S = ±5.0 V, VG2S = VDS = 0) | | lG1SS | _ | ±10 | nA |
| Gate 2 Leakage Current (VG2S = ±5.0 V, VG1S = VDS = 0) | | ^I G2SS | | ±10 | πA |
| Gate 1 to Source Cutoff Voltage (VDS = 15 V, VG2S = 4.0 V, ID = 20 μA) | | VG1S(off) | -0.5 | -4.0 | Vdc |
| Gate 2 to Source Cutoff Voltage (VDS = 15 V, VG1S = 0 V, ID = 20 μA) | | VG2S(off) | -0.2 | -4.0 | Vdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current* (VDS = 15 V, VG2S = 4.0 V, VG1S = 0 V) | | IDSS* | 6 | 30 | mA |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transfer Admittance $(V_{DS} = 15 \text{ V, } V_{G2S} = 4.0 \text{ V, } V_{G1S} = 0 \text{ V, } f = 1.0 \text{ kHz}) \text{ Note 2}$ | | Y _{fs} | 10 | 22 | mmhos |
| Input Capacitance (VDS = 15 V, VG2S = 4.0 V, ID = IDSS, f = 1.0 Mhz) | | C _{iss} | | yp. 1.0 | pF |
| Reverse Transfer Capacitance (VDS = 15 V, VG2S = 4.0 V, ID = 10 mA, f = 1.0 MHz) | | C _{rss} | 0.005 | 0.03 | pF |
| Output Capacitance (VDS = 15 V, VG2S = 4.0 V, ID = IDSS, f = 1.0 MHz) | | Coss | | yp. 1.4 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | | _ |
| Noise Figure (VDD = 18 V, VGG = 7.0 V, f = 200 MHz) (VDS = 15 V, VG2S = 4.0 V, ID = 10 mA, f = 450 MHz) | 3N204 3N204 | NF | = | 3.5 5.0 | dB |
| Common Source Power Gain (VDD = 18 V, VGG = 7.0 V, f = 200 MHz) (VDS = 15 V, VG2S = 4.0 V, ID = 10 mA, f = 450 MHz) | 3N204 3N204 | G _{ps} | 20 14 | 28 — | ₫B |

3N204, 3N205

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|--|-----------------|----------------------|------------|-----------|------|
| Bandwidth (V _{DD} = 18 V, V _{GG} = 7.0 V, f = 200 MHz) (V _{DD} = 18 V, f _{LO} = 245 MHz, f _{RF} = 200 MHz) (Note 4) | 3N3204 3N205 | BW | 7.0 4.0 | 12 7.0 | MHz |
| Gain Control Gate-Supply Voltage (Note 3) (V _{DD} = 18 V, ΔGPS = 300 dB, f = 200 MHz) | 3N204 | VGG(GC) | 0 | -2.0 | Vdc |
| Conversion Gain (Note 4) (V _{DD} = 18 V, f _{LO} = 245 MHz, f _{RF} = 200 MHz) | 3N205 | G _(conv.) | 17 | 28 | dB |

^{*}PW = 30 µsec, Duty Cycle ≤ 2.0%.

⁽¹⁾ All gate breakdown voltages are measured while the device is conducting rated gate current. This insures that the gate voltage limiting network is functioning propertly.

⁽²⁾ This parameter must be measured with bias voltages applied for less than five (5) seconds to avoid overheating. (3) ΔG_{ps} is defined as the change in G_{ps} from the value at $V_{GG} = 7.0 \text{ V}$. (4) Amplitude at input from local oscillator is 3 volts RMS.

MAXIMUM RATINGS

| MAXIMUM RATINGS | | | | |
|--|--------------------------------------|------------------|------------------|-------------|
| Rating | Symbol | Va | Unit | |
| Drain-Source Voltage | VDS | 25 | | Vdc |
| Drain-Gate Voltage | V _{DG1} V _{DG2} | | 30 30 | |
| Drain Current | ā | 3 | 0 | mAdc |
| Gate Current | IG1R IG1F IG2R IG2F | - 1 - 1 | mAdc | |
| | | 3N209 | MPF209 | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 1.71 | <u>-</u> | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | | 300 2.4 | mW mW/°C |
| Lead Temperature, 1/16" From Seated Surface for 10 seconds | ΤL | 260 200 | | °C |
| Storage Channel Temperature Range | T _{stg} | - 65 to + 175 | - 65 to + 150 | °C |
| Operating Channel Temperature | T _{channel} | 175 | 150 | °C |

3N209 MPF209

3N209 CASE 20-03, STYLE 9 TO-72 (TO-206AF)

MPF209 CASE 317-01, STYLE 1

DUAL-GATE MOSFET UHF COMMUNICATIONS

N-CHANNEL — DEPLETION

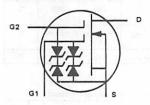
| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|------------------|----------|-------|------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Drain-Source Breakdown Voltage (ID = 10 µAdc, VG1S = -4.0 Vdc, VG2S = 4.0 Vdc) | V(BR)DSX | 25 | 1 | ı | Vdc |
| Gate 1 — Source Forward Breakdown Voltage (IG1 = 10 mAdc, VG2S = VDS = 0) | V(BR)G1SSF | 7.0 | 1 | 22 | Vdc |
| Gate 1 — Source Reverse Breakdown Voltage (IG1 = -10 mAdc, VG2S = VDS = 0) | V(BR)G1SSR | -7.0 | - | -22 | Vdc |
| Gate 2 — Source Forward Breakdown Voltage (I _{G2} = 10 mAdc, V _{G1S} = V _{DS} = 0) | V(BR)G2SSF | 7.0 | ı | 22 | Vdc |
| Gate 2 — Source Reverse Breakdown Voltage (IG2 = -10 mAdc, VG1S = VDS = 0) | V(BR)G2SSR | -7.0 | ŀ | -22 | Vdc |
| Gate 1 — Terminal Forward Current (VG1S = 6.0 Vdc, VG2S = VDS = 0) | lG1SSF | _ | - | 20 | nAdc |
| Gate 1 — Terminal Reverse Current (VG1S = -6.0 Vdc, VG2S = VDS = 0) (VG1S = -6.0 Vdc, VG2S = VDS = 0, TA = 150°C) | IG1SSR | = | 11 | -20 -10 | nAdc μAdc |
| Gate 2 — Terminal Forward Current (VG2S = 6.0 Vdc, VG1S = VDS = 0) | IG2SSF | - | - | 20 | nAdc |
| Gate 2 — Terminal Reverse Current (VG2S = -6.0 Vdc, VG1S = VDS = 0) (VG2S = -6.0 Vdc, VG1S = VDS = 0, T _A = 150°C) | IG2SSR | <u> </u> | - | -20 -10 | nAdc µAdc |
| ON CHARACTERISTICS | | | | | |
| Gate 1 — Zero Voltage Drain Current (VDS = 15 Vdc, VG1S = 0, VG2S = 4.0 Vdc) | IDSS | 5.0 | _ | 30 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transfer Admittance (VDS = 15 Vdc, VG2S = 4.0 Vdc, ID = 10 mAdc, f = 1.0 kHz) | Yfs | 10 | 13 | 20 | mmhos |
| Input Capacitance (VDS = 15 Vdc, VG2S = 4.0 Vdc, ID ≥ 5.0 mAdc, f = 1.0 MHz) | C _{iss} | _ | 3.3 | 7.0 | pF |
| Reverse Transfer Capacitance (VDS = 15 Vdc, VG2S = 4.0 Vdc, ID > 5.0 mAdc, f = 1.0 MHz) | C _{rss} | 0.005 | 0.023 | 0.03 | pF |
| Output Capacitance (VDS = 15 Vdc, VG2S = 4.0 Vdc, ID > 5.0 mAdc, f = 1.0 MHz) | C _{OSS} | 0.5 | 2.0 | 4.0 | pF |

3N209, MPF209

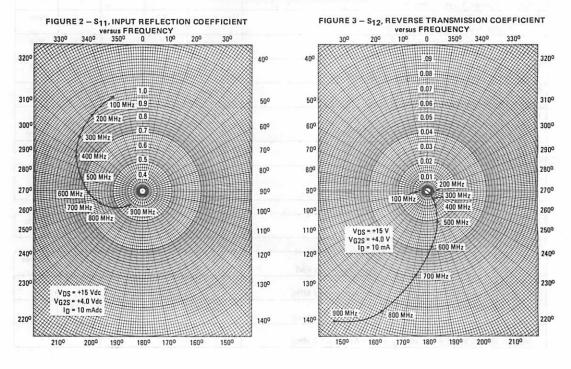
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

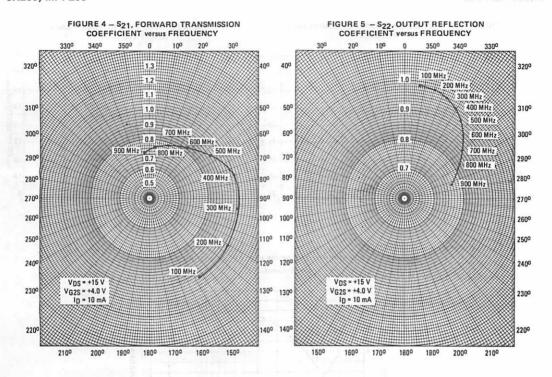
| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|-----------------|-----|-----|---------|------------|
| FUNCTIONAL CHARACTERISTICS | | | | 10-10-0 | Digestion. |
| Noise Figure (V _{DS} = 15 Vdc, V _{G2S} = 4.0 Vdc, I_D = 10 mAdc, f = 500 MHz) | NF | _ | 4.0 | 6.0 | dB |
| Common Source Power Gain (Figure 12) (V _{DS} = 15 Vdc, V _{G2S} = 4.0 Vdc, I _D = 10 mAdc, f = 500 MHz) | G _{ps} | 10 | 13 | 20 | dB |
| *Bandwidth $(V_{DS} = 15 \text{ Vdc}, V_{G2S} = 4.0 \text{ Vdc}, I_D = 10 \text{ mAdc}, f = 500 \text{ MHz})$ | BW | 7.0 | | 17 | MHz |

FIGURE 1 - MOS FET CIRCUIT SCHEMATIC



TYPICAL SCATTERING PARAMETERS





TYPICAL COMMON-SOURCE ADMITTANCE PARAMETERS

 $(V_{DS} = 15 \text{ Vdc}, V_{GS2} = 4.0 \text{ Vdc}, I_{D} = 10 \text{ mAdc})$

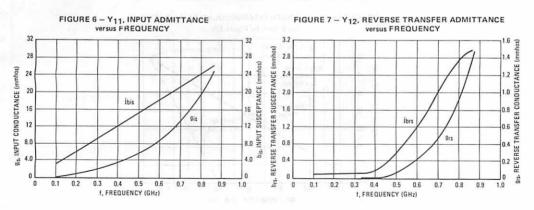


FIGURE 8 – Y₂₁, FORWARD TRANSFER ADMITTANCE
VOTSUS FREQUENCY

FIGURE 9 – Y₂₂, OUTPUT ADMITTANCE versus FREQUENCY

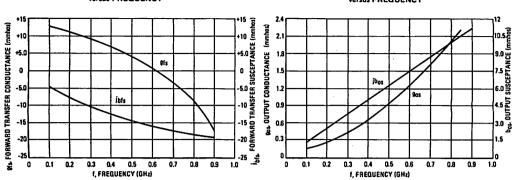
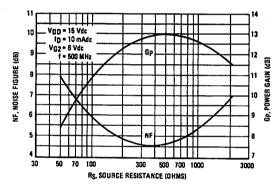


FIGURE 10 - POWER GAIN AND NOISE FIGURE versus SOURCE RESISTANCE
(See Schematic Figure 12)



The Test Circuit shown in Figure 12 was used to generate Power Gain and Noise Figure as a function of Source Resistance curves.

FIGURE 11 - THIRD ORDER INTERMODULATION DISTORTION

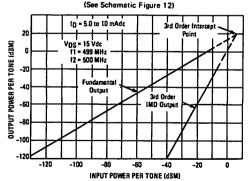
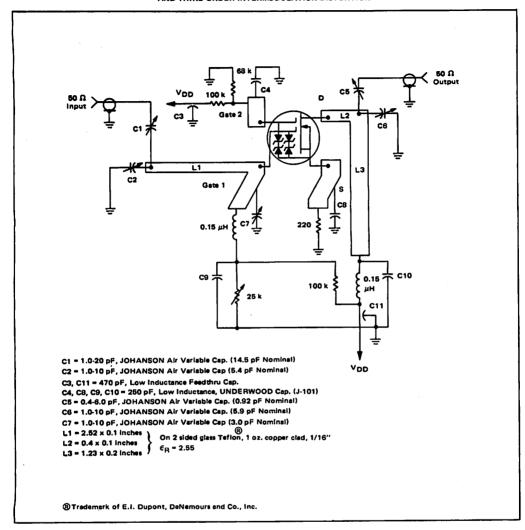


Figure 11 shows the typical third order intermodulation distortion (IMD) performance of the 3N209 and 3N210 at 500 MHz.

Both fundamental output and third order IMD output characteristics are plotted. The curves have been extrapolated to show the third order intermodulation output intercept point.

The performance is typical for ID between 5.0 mAdc and 10 mAdc. The test circuit shown in Figure 12 was used to generate the IMD Data.

FIGURE 12 — TEST CIRCUIT FOR POWER GAIN, NOISE FIGURE AND THIRD ORDER INTERMODULATION DISTORTION



3N211 3N212 3N213

CASE 20-03, STYLE 9 TO-72 (TO-206AF)

> DUAL-GATE MOSFET VHF AMPLIFIER

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

| | Γ | _ | |
|--------------------------------------|-----------------------------------|--|---|
| Symbol | 3N211 3N212 | 3N213 | Unit |
| V _{DS} | 27 35 | | Vdc |
| V _{DG1} V _{DG2} | 35 40 35 40 | | Vdc |
| lD | 5 | mAdc | |
| IG1 IG2 | . – | mAdc | |
| PD | 360 2.4 | | mW mW/°C |
| PD | 1.2 8.0 | | Watt mW/°C |
| TL | 300 | | °C |
| TJ | -65 to | °C | |
| T _{stq} | -65 to | + 175 | ℃ |
| | VDS VDG1 VDG2 ID IG1 IG2 PD TL TJ | VDS 27 VDG1 35 VDG2 35 ID 5 IG1 ± IG2 ± PD 31 2 PD 1 8 TL 36 TJ -65 tc | Symbol 3N212 3N213 VDS 27 35 VDG1 35 40 VDG2 35 40 ID 50 IG1 ± 10 IG2 ± 10 PD 360 2.4 PD TL 300 TJ -65 to + 175 |

Refer to MPF211 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|--------------------|----------------------|----------------|----------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Drain-Source Breakdown Voltage (I _D = 10 μAdc, V _{G1S} = V _{G2S} = -4.0 Vdc) | 3N211,212 3N213 | V _{(BR)DSX} | 25 30 | = | Vdc |
| Instantaneous Drain-Source Breakdown Voltage)(1) (ID = 10 µAdc, VG1S = VG2S = -4.0 Vdc) | 3N211,212 3N213 | V(BR)DSX | 27 35 | = | Vdc |
| Gate 1-Source Breakdown Voltage(2) (IG1 = ±10 mAdc, VG2S = VDS = 0) | | V(BR)G1SO | ±6.0 | _ | Vdc |
| Gate 2-Source Breakdown Voitage(2) (I _{G2} = ±10 mAdc, V _{G1S} = V _{DS} = 0) | | V(BR)G2SO | ±6.0 | _ | Vdc |
| Gate 1 Leakage Current (VG1S = ±5.0 Vdc, VG2S = VDS = 0) (VG1S = -5.0 Vdc, VG2S = VDS = 0, TA = 150°C) | | ^I G1SS | <u> </u> | ±10 -10 | nAdc µAdc |
| Gate 2 Leakage Current (VG2S = ±5.0 Vdc, VG1S = VDS = 0) (VG2S = -5.0 Vdc, VG1S = VDS = 0, TA = 150°C) | | I _{G2SS} | = | ±10 -10 | nAdc |
| Gate 1 to Source Cutoff Voltage (VDS = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 20 μ Adc) | 3N211,213 3N212 | VG1S(off) | - 0.5 - 0.5 | -5.5 -4.0 | Vdc |
| Gate 2 to Source Cutoff Voltage (V _{DS} = 15 Vdc, V _{G1S} = 0, I _D = 20 μAdc) | 3N211 3N212,213 | VG2S(off) | -0.2 -0.2 | - 2.5 - 4.0 | Vdc |
| ON CHARACTERISTICS | · · · | | | | |
| Zero-Gate-Voltage Drain Current(3) (VDS = 15 Vdc, VG1S = 0, VG2S = 4.0 Vdc) | | DSS | 6.0 | 40 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | ' | <u> </u> |
| Forward Transfer Admittance(4) (VDS = 15 Vdc, VG2S = 4.0 Vdc, VG1S = 0, f = 1.0 kHz) | 3N211,212 3N213 | lYfsl | 17 15 | 40 35 | mmhos |
| Reverse Transfer Capacitance (Vps = 15 Vdc, Vg2s = 4.0 Vdc, Ip = 10 mAdc, f = 1.0 MHz) | | C _{rss} | 0.005 | 0.05 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | | |
| Noise Figure (Vpp = 18 Vdc, Vgg = 7.0 Vdc, f = 200 MHz) (Vpp = 24 Vdc, Vgg = 8.0 Vdc, f = 45 MHz) | 3N211 3N211,13 | NF | = | 3.5 4.0 | dB |

3N211, 3N212, 3N213

| Characteristic | | Symbol | Miln | Max | Unit |
|--|-----------|--------------------|------|-------|------|
| Common Source Power Gain | | G _{DS} | | 1 1 | ₫B |
| (VDD = 18 Vdc, VGG = 7.0 Vdc, f = 200 MHz) | 3N211 | " | 24 | 35 | |
| (VDD = 24 Vdc, VGG = 6.0 Vdc, f = 45 MHz) | 3N211 | 1 | 29 | 37 | 1 |
| (VDD = 24 Vdc, VGG = 6.0 Vdc, f = 45 MHz) | 3N213 | | 27 | 35 | |
| (VDD = 18 Vdc, fLO = 245 MHz, fRF = 200 MHz) | 3N212 | G _c (6) | 21 | 28 | |
| Bandwidth | | BW | | | MHz |
| (V _{DD} = 18 Vdc, V _{GG} = 7.0 Vdc, f = 200 MHz) | 3N211 | i i | 5.0 | 12 | |
| (VDD = 18 Vdc, fLO = 245 MHz, fRF = 200 MHz) | 3N212 | | 4.0 | 7.0 | |
| (VDD = 24 Vdc, VGG = 6.0 Vdc, f = 45 MHz) | 3N211,213 | 1 | 3.5 | 6.0 | |
| Gain Control Gate-Supply Voltage(5) | | VGG(GC) | - | | Vdc |
| $(V_{DD} = 18 \text{ Vdc}, \Delta G_{ps} = -30 \text{ dB}, f = 200 \text{ MHz})$ | 3N211 | 55,00, | _ | - 2.0 | l |
| $(V_{DD} = 24 \text{ Vdc}, \Delta G_{DS} = -30 \text{ dB}, f = 45 \text{ MHz})$ | 2N211,213 | | _ | ± 1.0 | l |

⁽¹⁾ Measured after five seconds of applied voltage.

⁽²⁾ All gate breakdown voltages are measured while the device is conducting rated gate current. This ensures that the gate-voltage limiting network is functioning properly.

⁽³⁾ Pulse Test: Pulse Width = 300 µs, Duty Cycle ≤ 2.0%.

⁽⁴⁾ This parameter must be measured with bias voltages applied for less than 5 seconds to avoid overheating. The signal is applied to gate 1 with gate 2 at ac ground.

⁽⁵⁾ ΔG_{ps} is defined as the charge in G_{ps} from the value at $V_{GG} = 7.0$ Volts (3N211) and $V_{GG} = 6.0$ Volts (3N213). (6) Power Gain Conversion. Amplitude at input from local oscillator is adjusted for maximum G_{c} .

BS107,A

CASE 29-02, STYLE 30 TO-92 (TO-226AA)

TMOS SWITCHING

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|----------------------|------------|-------|
| Drain-Source Voltage | VDS | 200 | Vdc |
| Gate-Source Voltage | VGS | ± 20 | Vdc |
| Drain Current Continuous(1) Pulsed(2) | I _D | 250 500 | mAdc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 0.6 | Watts |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to 150 | °C |

⁽¹⁾ The Power Dissipation of the package may result in a lower continuous drain current.

Refer to MFE9200 for graphs.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|------------------|-----|--------------------|-----------------|--|
| OFF CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current (VDS = 130 V, VGS = 0) | loss | _ | _ | 30 | nAdc |
| Drain-Source Breakdown Voltage (VGS = 0, I _D = 10 μA) | V(BR)DSX | 200 | - | _ | Vdc |
| Gate Reverse Current (VGS = 15 Vdc, VDS = 0) | lgss | _ | 0.01 | 10 | nAdc |
| ON CHARACTERISTICS* | | | | <u> </u> | <u>. </u> |
| Gate Threshold Voltage (ID = 1.0 mA, VDS = VGS) | VGS(Th) | 1.0 | - | 3.0 | Vdc |
| Static Drain-Source On Resistance BS107 | 「DS(on) | - | | | Ohms |
| (VGS = 2.6 V, I _D = 20 mA) (VGS = 10 V, I _D = 200 mA) BS107A (VGS = 10 Vdc) (I _D = 100 mA) | | = | _ _ _ 4.5 | 28 14 6.0 | |
| (tp = 250 mA) | | _ | 4.8 | 6.4 |) |
| SMALL-SIGNAL CHARACTERISTICS | | | | _ | |
| Input Capacitance (VDS = 25 V, VGS = 0, f = 1.0 MHz) | C _{iss} | _ | 72 | 90 | pF |
| Reverse Transfer Capacitance (VDS = 25 V, VGS = 0, f = 1.0 MHz) | C _{rss} | _ | 2.8 | 3.5 | pF |
| Output Capacitance (VDS = 25 V, VGS = 0, f = 1.0 MHz) | Coss | _ | 15 | 20 | pF |
| Forward Transconductance (Vps = 25 V, lp = 250 mA) | 9fs | 200 | 400 | _ | mmhos |
| SWITCHING CHARACTERISTICS | | | | | |
| Turn-On Time | t _{on} | | 6.0 | 15 | ns |
| Turn-Off Time | toff | _ | 12 | 15 | ns |

^{*}Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

⁽²⁾ Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

BS170

CASE 29-02, STYLE 30 TO-92 (TO-226AA)

TMOS FET SWITCHING

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|------|
| Drain-Source Voltage | VDS | 60 | Vdc |
| Gate-Source Voltage | VGS | ±20 | Vdc |
| Drain Current(1) | lD | 0.5 | Adc |
| Total Device Dissipation @ T _C = 25°C | PD | 0.83 | Watt |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

⁽¹⁾ The Power Dissipation of the package may result in a lower continuous drain current.

Refer to 2N6659 for graphs.

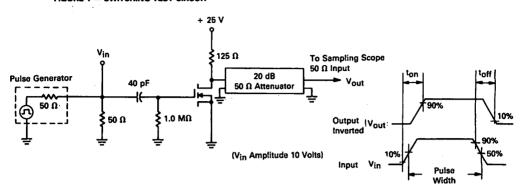
| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|---------------------|-----|------|-----|-------|
| OFF CHARACTERISTICS | | | | | |
| Gate Reverse Current (VGS = 15 V, VDS = 0) | IGSS | _ | 0.01 | 10 | nAdc |
| Drain-Source Breakdown Voltage (VGS = 0, ID = 100 µA) | V(BR)DSS | 60 | 90 | - | Vdc |
| ON CHARACTERISTICS(2) | | | | | |
| Gate Threshold Voltage (VDS = VGS, ID = 1.0 mA) | VGS(Th) | 0.8 | 2.0 | 3.0 | Vdc |
| Static Drain-Source On Resistance (VGS = 10 V, ID = 200 mA) | 「DS(on) | _ | 1.8 | 5.0 | Ohms |
| Drain Cutoff Current (VDS = 25 V, VGS = 0 V) | ^I D(off) | _ | - | 0.5 | μΑ |
| Forward Transconductance (Vps = 10 V, lp = 250 mA) | 9fs | _ | 200 | _ | mmhos |
| SMALL-SIGNAL CHARACTERISTICS | | | | | - |
| Input Capacitance (VDS = 10 V, VGS = 0, f = 1.0 MHz) | C _{iss} | _ | 60 | | pF |
| SWITCHING CHARACTERISTICS | | | | | |
| Turn-On Time (I _D = 0.2 A) See Figure 1 | t _{on} | _ | 4.0 | 10 | ns |
| Turn-Off Time (ID = 0.2 A) See Figure 1 | t _{off} | _ | 4.0 | 10 | ns |

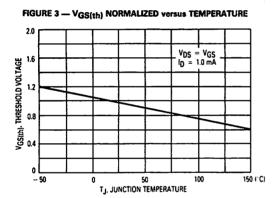
⁽²⁾ Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

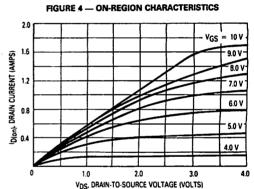
RESISTIVE SWITCHING

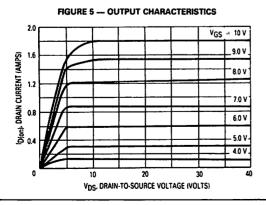
FIGURE 1 - SWITCHING TEST CIRCUIT

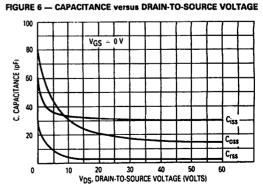
FIGURE 2 - SWITCHING WAVEFORMS











J107, J108 J109, J110

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET GENERAL-PURPOSE TRANSISTOR

N-CHANNEL — DEPLETION

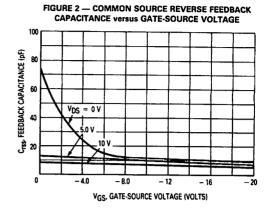
MAXIMUM RATINGS

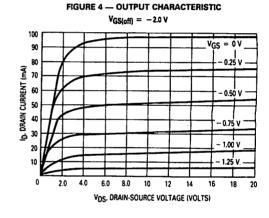
| Rating | Symbol | Value | Unit |
|---|--------|-------------|-------------|
| Drain-Gate Voltage | VDG | - 25 | Vdc |
| Gate-Source Voltage | VGS | - 25 | Vdc |
| Gate Current | lg | 10 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 310 2.82 | mW mW/°C |
| Junction Temperature Range | TJ | 135 | တ္ |
| Storage Channel Temperature Range | Tsta | -65 to +150 | °C |

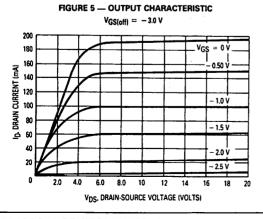
| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|------------------------------|---|------------------------------|------------------|-----------------------------|------|
| OFF CHARACTERISTICS | | | | | | |
| Gate-Source Breakdown Voltage (Vps = 0, lg = −10 µAdc) | | V _(BR) GSS | - 25 | - | _ | Vdc |
| Gate Reverse Current (VGS = -15 Vdc, VDS = 0) (VGS = -15 Vdc, VDS = 0, TA = 100°C) | | IGSS | 1.1 | 1 1 | -3.0 -200 | nAdc |
| Gate Source Cutoff Voltage (V _{DS} = 15 Vdc, I _D = 10 nAdc) | J107 J108 J109 J110 | VGS(off) | -0.5 -3.0 -2.0 -0.5 | 1 1 1 | -4.5 -10 -6.0 -4.0 | Vdc |
| ON CHARACTERISTICS | | | | | | |
| Zero-Gate-Voltage Drain Current(1) (VDS = 15, VGS = 0) | J107 J108 J109 J110 | loss | 100 80 40 10 | <u>-</u> | _ _ _ | mAdc |
| Drain-Source On-Resistance (VDS < 0.1 V, VGS = 0 V) | J107 J108 J109 J110 | 「DS(on) | _ _ _ _ | _ _ _ _ | 8.0 8.0 12 18 | ohms |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Drain Gate + Source Gate On-Capacitance (VDS = 0 Vdc, VGS = 0, f = 1.0 MHz) | | C _{dg(on)} + C _{sg(on)} | _ | _ | 85 | pF |
| Drain Gate Off-Capacitance (VDS = 0 Vdc, VGS = -10 V, f = 1.0 MHz) | | C _{dg(off)} | - | _ | 15 | pF |
| Source Gate Off-Capacitance (VDS = 0 Vdc, VGS = -10 V, f = 1.0 MHz) | | C _{sg(off)} | _ | _ | 15 | pF |

⁽¹⁾ Pulse Duration 300 µs, Duty Cycle ≤ 2.0%.

FIGURE 1 — COMMON SOURCE INPUT CAPACITANCE Versus GATE-SOURCE VOLTAGE







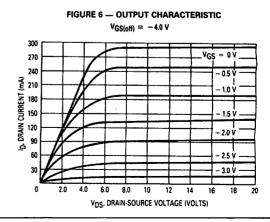
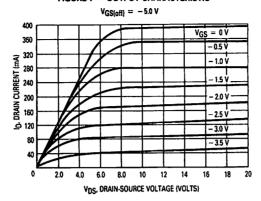


FIGURE 7 — OUTPUT CHARACTERISTIC



J111 J112 J113

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET CHOPPER

N-CHANNEL - DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|----------------------|-------------|-------------|
| Drain-Gate Voltage | VDG | -35 | Vdc |
| Gate-Source Voltage | VGS | - 35 | Vdc |
| Gate Current | IG | 50 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.68 | mW mW/°C |
| Lead Temperature | TL | 300 | °C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | •€ |

| Characteristic | | Symbol | Min | Max | Unit |
|--|----------------------|----------------------|----------------------|------------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (I _G = -1.0 μA) | | V(BR)GSS | 35 | _ | Vdc |
| Gate Reverse Current (VGS = -15 V) | | IGSS | | - 1.0 | nA |
| Gate Source Cutoff Voltage (V _{DS} = 5.0 V, I _D = 1.0 μA) | J111 J112 J113 | VGS(off) | -3.0 -1.0 -0.5 | - 10 - 5.0 - 3.0 | ٧ |
| Drain-Cutoff Current (VDS = 5.0 V, VGS = -10 V) | | I _D (off) | _ | 1.0 | nA |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current* (VDS = 15 V) | J111 J112 J113 | IDSS | 20 5.0 2.0 | = | mA |
| Static Drain-Source On Resistance (V _{DS} = 0.1 V) | J111 J112 J113 | ^r DS(on) | = | 33 50 100 | Ohms |
| Drain Gate and Source Gate On-Capacitance (VDS = VGS = 0, f = 1.0 MHz) | | C _{dg(on)} | _ | 28 | pF |
| Drain Gate Off-Capacitance (VGS = -10 V, f = 1.0 MHz) | | C _{dg(off)} | _ | 5.0 | pF |
| Source Gate Off-Capacitance (VGS = -10 V, f = 1.0 MHz) | | C _{sg(off)} | _ | 5.0 | pF |

^{*}Pulse Width = 300 µsec, Duty Cycle = 3.0%.

J174 J175 **J176** J177

CASE 29-02, STYLE 7 TO-92 (TO-226AA)

JFET CHOPPER TRANSISTOR

P-CHANNEL - DEPLETION

Refer to MPF970 for graphs.

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|-------------|
| Drain-Source Voltage | VDS | 30 | Vdc |
| Drain-Gate Voltage | VDG | 30 | Vdc |
| Gate-Source Voltage | VGS | 30 | Vdc . |
| Gate Current | IG | 50 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Temperature Range | T _{stg} | -65 to +150 | °C |

| Characteristic | | Symbol | Min | Max | Unit |
|--|------------------------------|----------|--------------------------|-------------------------|------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (IG = 1.0 μA) | | V(BR)GSS | 30 | _ | Vdc |
| Gate Reverse Current (VGS = 20 Volts) | | IGSS | - | 1.0 | nA |
| Gate Source Cutoff Voltage (VDS = -15 V, ID = -10 nA) | J174 J175 J176 J177 | VGS(off) | 5.0 3.0 1.0 0.8 | 10 6.0 4.0 2.5 | Vdc |

| ON | CHARA | CTER | ISTICS |
|----|-------|------|--------|
| | | | |

| Zero-Gate-Voltage Drain Current (VDS = -15 V) | J174 J175 J176 J177 | loss* | - 2.0 - 7.0 - 2.0 - 1.5 | - 100 - 60 - 25 - 20 | mA |
|--|------------------------------|---------|----------------------------------|-------------------------------|----|
| Static Drain-Source On Resistance (V _{DS} ≤ -0.1 Volt) | J174 J175 J176 J177 | rDS(on) | _ _ _ _ | 85 125 250 300 | Ω |

^{*}Pulse Width = 300 μs, Duty Cycle ≤ 3.0%.

J201 J202 J203

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET LOW FREQUENCY/LOW NOISE

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

| MAXIMUM RATINGS | | | |
|---|------------------|-------------|-------------|
| Rating | Symbol | Value | Unit |
| Drain-Source Voltage | VDS | 40 | Vdc |
| Drain-Gate Voltage | VDG | 40 | Vdc |
| Gate-Source Voltage | VGS | 40 | Vdc |
| Gate Current | l _G | 50 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 310 2.82 | mW mW/°C |
| Storage Temperature Range | T _{stg} | -65 to +150 | °C |

Refer to 2N4220 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|----------------------|-----------------------|----------------------|--------------------|-------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (I _G = -1.0 μA) | | V _(BR) GSS | -40 | _ | Vdc |
| Gate Reverse Current (VGS = -20 V) | | IGSS | | -100 | pA |
| Gate Source Cutoff Voltage (V _{DS} = 20 V, I _D = 10 nA) | J201 J202 J203 | VGS(off) | -0.3 -0.8 -2.0 | 1.5 4.0 10.0 | Vdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current (V _{DS} = 20 V) | J201 J202 J203 | lDSS* | 0.2 0.9 4.0 | 1.0 4.5 20.0 | mA |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transfer Admittance (VDS = 20 V, f = 1.0 kHz) | J201 J202 J203 | lyfsl* | 500 1000 1500 | = | μmhos |

^{*}Pulse Width ≤ 2.0 msec.

J270 J271

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET CHOPPER TRANSISTOR

P-CHANNEL — DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|-------------|
| Drain-Source Voltage | V _{DS} | 30 | Vdc |
| Drain-Gate Voltage | VDG | 30 | Vdc |
| Gate-Source Voltage | VGS | 30 | Vdc |
| Gate Current | IG | 50 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 360 3.27 | mW mW/°C |
| Storage Temperature Range | T _{sta} | -65 to +150 | °C |

Refer to MPF970 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------|------------------|--------------|----------------|-------|
| OFF CHARACTERISTICS | | | | | · |
| Gate-Source Breakdown Voltage (IG = 1.0 μA) | | V(BR)GSS | 30 | _ | Vdc |
| Gate Reverse Current (VGS = 20 Volts) | | IGSS | _ | 200 | pA |
| Gate Source Cutoff Voltage (VDS =15 V, tD = -1.0 nA) | J270 J271 | VGS(off) | 0.5 1.5 | 2.0 4.5 | Vdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current (Vps = -15 V) | J270 J271 | loss* | -2.0 -6.0 | - 15 - 50 | mA |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transfer Admittance (V _{DS} = -15 V, f = 1.0 kHz) | J270 J271 | lYfsl | 6000 8000 | 15000 18000 | μmhos |
| Output Admittance (VDS = -15 V, f = 1.0 kHz) | J270 J271 | lyosl | = | 200 500 | μπhos |
| Input Capacitance (VDS = -15 V, f = 1.0 MHz) | | C _{iss} | _ | 32 | pF |
| Reverse Transfer Capacitance (V _{DS} = -15 V, f = 1.0 MHz) | | C _{rss} | _ | 8.0 | pF |

^{*}Pulse Width ≤ 2.0 ms.

J300

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET HIGH FREQUENCY AMPLIFIER

N-CHANNEL - DEPLETION

MAXIMUM RATINGS

| MAXIMOM NATINGS | | | |
|---|------------------|-------------|------------|
| Rating | Symbol | Value | Unit_ |
| Drain-Gate Voltage | VDG | - 25 | Vdc |
| Gate Current | IG | 10 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 3.5 | mW mW/℃ |
| Lead Temperature (1/16" from Case for 10 Seconds) | TL | 300 | ပ္ |
| Junction Temperature Range | Tj | -55 to +150 | •€ |
| Storage Temperature Range | T _{stq} | -55 to +150 | °C |

| Characteristic | Symbol | Min | Max | Unit |
|---|--------------------|------|------|-------|
| OFF CHARACTERISTICS | | | | |
| Gate-Source Breakdown Voltage (I _G = -1.0 μA, V _{DS} = 0) | V(BR)GSS | -25 | _ | Vdc |
| Gate Reverse Current (VGS = -15 V, VDS = 0) | Igss | _ | 500 | pA |
| Gate Source Cutoff Voltage (V _{DS} = 10 V, I _D = 1.0 mA) | VGS(off) | -1.0 | -6.0 | Vdc |
| ON CHARACTERISTICS | | | | |
| Zero-Gate-Voltage Drain Current (VDS = 10 V, VGS = 0) | IDSS | 6.0 | 30 | mA |
| Gate-Source Forward Voltage (Vps = 0, lg = 1.0 mA) | V _{GS(f)} | _ | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Forward Transfer Admittance (VDS = 10 V, ID = 5.0 mA, f = 1.0 kHz) | lyfsl | 4500 | 9000 | μmhos |
| Output Admittance (V _{DS} = 10 V, I _D = 5.0 mA, f = 1.0 kHz) | lYosl | _ | 200 | μmhos |
| Input Capacitance (V _{DS} = 10 V, I _D = 5.0 mA, f = 1.0 MHz) | C _{iss} | | 5.5 | pF |
| Reverse Transfer Capacitance (Vps = 10 V, lp = 5.0 mA, f = 1.0 MHz) | C _{rss} | _ | 1.7 | pF |

J304 J305

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET HIGH FREQUENCY AMPLIFIER

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|-------------|
| Drain-Gate Voltage | VDG | -30 | Vdc |
| Gate-Source Voltage | V _{GS} | -30 | Vdc |
| Gate Current | IG | 10 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 3.5 | mW mW/°C |
| Lead Temperature (1/16" from Case for 10 Seconds) | TL | 300 | េះ |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

| Characteristic | | Symbol | Min | Max | Unit |
|---|--------------|----------|----------------|--------------|-------|
| OFF CHARACTERISTICS | | | | • | |
| Gate-Source Breakdown Voltage (IG = 1.0 μA, VDS = 0) | | V(BR)GSS | 30 | _ | Vdc |
| Gate Reverse Current (VGS = -20 V, VDS = 0) | | IGSS | - | 100 | pΑ |
| Gate Source Cutoff Voltage (V _{DS} = 15 V, I _D = 1.0 nA) | J304 J305 | VGS(off) | - 2.0 - 0.5 | -6.0 -3.0 | Vdc |
| ON CHARACTERISTICS | | | | | • |
| Zero-Gate-Voltage Drain Current (VDS = 15 V, VGS = 0) | J304 J305 | loss | 5.0 1.0 | 15 8.0 | mA |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Output Admittance (Vps = 15 V, Vgs = 0, f = 1.0 kHz) | | lyosl | _ | 50 | μmhos |
| Forward Transconductance (VDS = 15 V, VGS = 0, f = 1.0 kHz) | J304 J305 | Re(yfs) | 4500 3000 | 7500 | μmhos |

J308 J309 J310

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET VHF/UHF AMPLIFIER

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|------------------|-------------|-------------|
| Drain-Source Voltage | VDS | 25 | Vdc |
| Gate-Source Voltage | VGS | 25 | Vdc |
| Forward Gate Current | IGF | 10 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 3.5 | mW mW/°C |
| Junction Temperature Range | TJ | -55 to +125 | ° |
| Storage Temperature Range | T _{stq} | -55 to +150 | °C |

Refer to U308 for graphs.

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|----------------------|----------------------|-------------------------|-------------------|-------------------------|-------------|
| OFF CHARACTERISTICS | | | | | | |
| Gate-Source Breakdown Voltage (I _G = -1.0 μA, V _{DS} = 0) | | V(BR)GSS | - 25 | _ | _ | Vdc |
| Gate Reverse Current (VGS = -15 V, VDS = 0, TA = 25°C) (VGS = -15 V, VDS = 0, TA = +125°C) | | IGSS | - - | - - | - 1.0 - 1.0 | nΑ μΑ |
| Gate Source Cutoff Voltage (V _{DS} = 10 V, ! _D = 1.0 nA) | J308 J309 J310 | VGS(off) | - 1.0 - 1.0 - 2.0 | = | -6.5 -4.0 -6.5 | Vdc |
| ON CHARACTERISTICS | | | | | | |
| Zero-Gate-Voltage Drain Current(1) (VDS = 10 V, VGS = 0) | J308 J309 J310 | loss | 12 12 24 | | 60 30 60 | mA |
| Gate-Source Forward Voltage (Vps = 0, lg = 1.0 mA) | | V _{GS(f)} | _ | - | 1.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | • | | | • | |
| Common-Source Input Conductance (VDS = 10 V, ID = 10 mA, f = 100 MHz) | J308 J309 J310 | Re(y _{is}) | | 0.7 0.7 0.5 | = | mmhos |
| Common-Source Output Conductance (Vps = 10 V, lp = 10 mA, f = 100 MHz) | | Re(y _{OS}) | _ | 0.25 | _ | mmhos |
| Common-Gate Power Gain (Vps = 10 V, lp = 10 mA, f = 100 MHz) | | Gpg | _ | 16 | _ | dB |
| Common-Source Forward Transconductance (Vps = 10 V, lp = 10 mA, f = 100 MHz) | | Re(yfs) | _ | 12 | - | mmhos |
| Common-Gate Input Conductance (Vps = 10 V, !p = 10 mA, f = 100 MHz) | | Re(yig) | _ | 12 | - | mmhos |
| Common-Gate Forward Transconductance (VDS = 10 V, ID = 10 mA, f = 1.0 kHz) | J308 J309 J310 | 9fs | 8000 10000 8000 | _ | 20000 20000 18000 | μmhos |
| Common-Gate Output Conductance (VDS = 10 V, ID = 10 mA, f = 1.0 kHz) | J308 J309 J310 | gos | = | = | 200 150 200 | μmhos |

J308, J309, J310

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|----------------------|-----------------|-------|-------------------------|-----|--------|
| Common-Gate Forward Transconductance (VDS = 10 V, ID = 10 mA, f = 1.0 kHz) | J308 J309 J310 | 9fg | _ | 13000 13000 12000 | = | μmhos |
| Common-Gate Output Conductance (V _{DS} = 10 V, I _D = 10 mA, f = 1.0 kHz) | J308 J309 J310 | gog | = | 150 100 150 | = | μmhos |
| Gate-Drain Capacitance (VDS = 0, VGS = -10 V, f = 1.0 MHz) | | C _{gd} | | 1.8 | 2.5 | pF |
| Gate-Source Capacitance (VDS = 0, VGS = -10 V, f = 1.0 MHz) | <u></u> | C _{gs} | _ | 4.3 | 5.0 | pF |
| FUNCTIONAL CHARACTERISTICS | | | · | -4 | | |
| Noise Figure (VDS = 10 V, ID = 10 mA, f = 450 MHz) | | NF | _ | 1.5 | _ | dB |
| Equivalent Short-Circuit Input Noise Voltage (VDS = 10 V, ID = 10 mA, f = 100 Hz) | | ēn | _ | 10 | _ | nV/√Hz |

⁽¹⁾ Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 3.0%.

JF1033B JF1033S JF1033Y

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET HIGH FREQUENCY AMPLIFIER

N-CHANNEL DEPLETION

MAXIMUM RATINGS

| WAAMON NATINGO | | | | | | |
|---|-----------------------------------|-------------|-------------|--|--|--|
| Rating | Symbol | Value | Unit | | | |
| Drain-Source Voltage | VDS | 20 | Vdc | | | |
| Gate-Source Voltage | VGS | 25 | Vdc | | | |
| Drain Current | ID | 20 | mA | | | |
| Forward Gate Current | IGF | 10 | mA | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 310 2.82 | mW mW/°C | | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +150 | °C | | | |

| Characteristic | | Symbol | Min | Max | Unit |
|---|-------------------------------|-----------------------|--------------------|---------------------|-------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (I _G = −10 µA) | | V _(BR) GSS | -25 | _ | Vdc |
| Drain-Source Breakdown Voltage (I _D = 10 μA) | | V(BR)DGO | 20 | _ | Vdc |
| Gate Reverse Current (VGS = -10 V, VpS = 0) | | lgss | _ | - 100 | nA |
| Gate Source Cutoff Voltage (V _{DS} = 10 V, I _D = 10 μ A) | | VGS(off) | - 1.0 | -8.0 | Vdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current (VDS = 10 V, VGS = 0) | JF1033Y JF1033B JF1033S | IDSS | 2.5 5.0 10.0 | 6.0 12.0 20.0 | mA |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transconductance (Vps = 10 V, Vgs = 0, f = 1.0 kHz) | | Re(yfs) | 4.5 | 13.0 | mmhos |
| FUNCTIONAL CHARACTERISTICS | | | | | |
| Noise Figure (Vps = 10 V, Vgs = 0, f = 100 MHz) | | NF | _ | 2.5 | dB |

MFE120 MFE121 MFE122

CASE 20-03, STYLE 9 TO-72 (TO-206AF)

DUAL-GATE MOSFET VHF AMPLIFIER

N-CHANNEL - DEPLETION

MAXIMUM RATINGS

| THE CONTROL OF THE CO | | | |
|---|----------------------|-------------|-------------|
| Rating | Symbol | Value | Unit |
| Drain-Source Voltage | VDS | + 25 | Vdc |
| Drain Current | lD | 30 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 1.7 | mW mW/°C |
| Operating and Storage Junction Temperature Range | Tj, T _{stg} | -65 to +175 | °C |

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|----------------------------|-------------------|-------------------|------------------|------------------|-------|
| OFF CHARACTERISTICS | | | | | | |
| Drain-Source Breakdown Voltage (ID = 100 μAdc, VS = 0, VG1S = -4.0 V, VG2S = +4. | I.O V) | V(BR)DSX | 25 | _ | _ | Vdc |
| Gate 1-Source Breakdown Voltage (IG1 = ±10 μAdc, VG2S = 0) | | V(BR)G1SO | ±7.0 | | ± 20 | Vdc |
| Gate 2-Source Breakdown Voltage (IG2 = ±10 μAdc, VG2S = 0) | | V(BR)G2SO | ± 7.0 | 1 | ±20 | Vdc |
| Gate 1 Leakage Current (VG1S = +6.0 Vdc, VG2S = 0, VDS = 0) | | IG1SS | ı | _ | 20 | nAdc |
| Gate 2 Leakage Current (VG2S = +6.0 Vdc, VG1S = 0, VDS = 0) | | ¹ G2SS | 1 | _ | 20 | nAdc |
| Gate 1 to Source Cutoff Voltage (VDS = 15 Vdc, VG2S = 4.0 Vdc, ID = 200 μAdc) | | VG1S(off) | 1 | - | -4.0 | Vdc |
| Gate 2 to Source Cutoff Voltage (VDS = 15 Vdc, VG1S = 0, ID = 200 μAdc) | | VG2S(off) | 1 | - | -4.0 | Vdc |
| ON CHARACTERISTICS | _ | | | | | |
| Zero-Gate-Voltage Drain Current (V _{DS} = 15 Vdc, V _{G1S} = 0, V _{G2S} = 4.0 Vdc) | MFE120 MFE121 MFE122 | IDSS | 2.0 5.0 2.0 | 7.0 10 9.0 | 18 30 20 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | • | |
| Forward Transfer Admittance (Gate 1 to Drain) (VDS = 15 Vdc, VG2S = 4.0 Vdc, ID = 10 mAdc, f = 1.0 kHz) | MFE120,22 MFE121 | Y _{fs} | 8000 10,000 | - | 18,000 20,000 | μmhos |
| Input Capacitance (VDS = 15 Vdc, VG2S = 4.0 Vdc, ID = IDSS, f = 1.0 MHz) | MFE120,22 MFE121 | C _{iss} | 11 | 4.5 4.5 | 7.0 6.0 | pF |
| Reverse Transfer Capacitance (VDS = 15 Vdc, VG2S = 4.0 Vdc, ID = 6.0 mAdc, f = 1.0 MHz) | | C _{rss} | - | 0.023 | _ | pF |
| Output Capacitance (VDS = 15 Vdc, VG2S = 4.0 Vdc, ID = IDSS, f = 1.0 MHz) | MFE120,22 MFE121 | C _{OSS} | - | 2.5 2.5 | 4.0 3.5 | pF |

MFE120, MFE121, MFE122

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

| Characteristic | - | Symbol | Min | Тур | Max | Unit |
|--|---------------|----------------|-----|------|-----|------|
| FUNCTIONAL CHARACTERISTICS | | | | | | |
| Noise Figure | . | NF | | | | dB |
| (VDS = 15 Vdc, VG2S = 4.0 Vdc, | | | |] | |) |
| ID = 6.0 mAdc, Zs is optimized for NF) | | | | | | Į. |
| (f = 105 MHz — Figure 1) | MFE120 | ļ | - | 2.9 | 5.0 | |
| (f = 60 MHz — Figure 3) | MFE121 | 1 | _ | 2.6 | 5.0 | |
| (f = 200 MHz — Figure 3) | MFE121 | | _ | 2.6 | 5.0 | |
| Common Source Power Gain | | Gps | | | | dB |
| (VDS = 15 Vdc, VG2S = 4.0 Vdc, | | " | | | ı | |
| In = 6.0 mAdc, Zs is optimized for NF) | | | | | | |
| (f = 105 MHz — Figure 1) | MFE120 | İ | 17 | 19.6 | _ | |
| (f = 60 MHz — Figure 3) | MFE121 | 1 | 20 | 27.8 | _ | |
| (f = 200 MHz — Figure 3) | MFE121 | | 17 | 18.6 | _ | |
| Level of Unwanted Signal for 1.0% Cross Modulation | | _ | | 100 | _ | m۷ |
| $(V_{DS} = 15 \text{ Vdc}, V_{G2S} = 4.0 \text{ Vdc}, I_{D} = 6.0 \text{ mAdc})$ | | | | | | |
| Common-Source Conversion Power Gain (Gate 1 Injection | n, Figure 2) | G _C | | | | dB |
| (VDS = 15 Vdc, VG2S = 4.0 Vdc, Local | | 1 | 1 | 1 . | | |
| Oscillator Voltage = 925 mVrms) | | | 1 | 1 | | |
| (Signal Frequency = 60 MHz, Local Oscillator | | | 1 | | | 1 |
| Frequency = 104 MHz) | MFE122 | | 15 | 16.5 | l – | |
| (Signal Frequency = 200 MHz, Local Oscillator | | | 1 | 1 | | 1 |
| Frequency = 244 MHz) | MFE122 | 1 | 12 | 13.3 | l – | ļ |

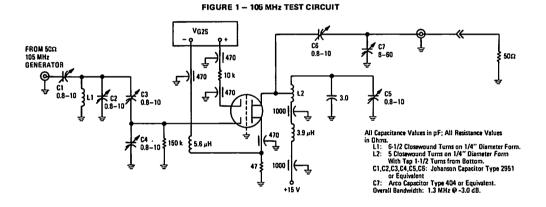


FIGURE 2 - 60 AND 200 MHz TEST CIRCUIT

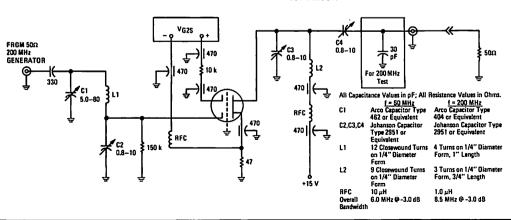
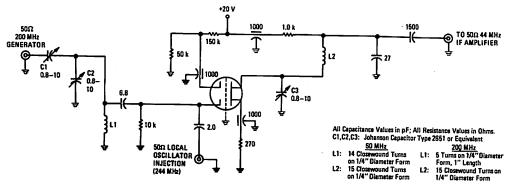
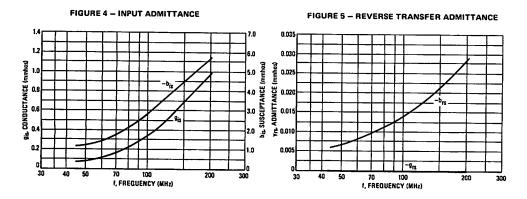
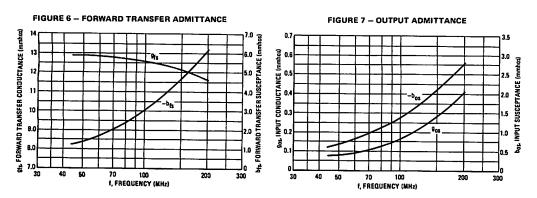


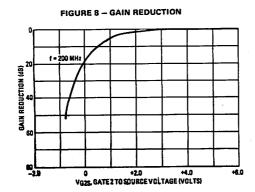
FIGURE 3 - 60 AND 200 MHz CONVERSION POWER GAIN

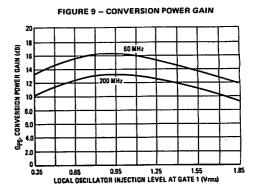


COMMON-SOURCE ADMITTANCE PARAMETERS ($V_{DS} = 15 \text{ Vdc}, V_{G2S} = 4.0 \text{ V,dc}, I_D = 6.0 \text{ mAdc}$)









MFE140

CASE 20-03, STYLE 9 TO-72 (TO-206AF)

> **DUAL-GATE** MOSFET **FM AMPLIFIER**

N-CHANNEL - DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------------|-------------|------|
| Drain-Source Voltage | VDS | 25 | Vdc |
| Gate-Source Voltage | VGS | ±7.0 | Vdc |
| Drain Current | ĺρ | 30 | mAdc |
| Gate Current | l _G | 10 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 | mW |
| Operating and Storage Channel Temperature Range | T _{channel} , | -65 to +175 | °C |

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|------------------|-------|-------|------|----------|
| OFF CHARACTERISTICS | | | | | 1 |
| Drain-Source Breakdown Voltage ($l_D = 10 \mu Adc$, $V_S = 0$, $V_{G1} = -4.0 \text{ Vdc}$, $V_{G2} = +4.0 \text{ Vdc}$) | V(BR)DSX | 25 | _ | - | Vdc |
| Gate 1-Source Breakdown Voltage (I _{G1} = ±10 μAdc, V _{G2S} = 0) | V(BR)G1SO | ±7.0 | - | ± 20 | Vdc |
| Gate 2-Source Breakdown Voltage (I _{G2} = ±10 μAdc, V _{G2S} = 0) | V(BR)G2SO | ± 7.0 | - | ± 20 | Vdc |
| Gate 1 Leakage Current (VG1S = ±6.0 Vdc, VG2S = 0, VDS = 0) | lG1SS | _ | - | 20 | nAdc |
| Gate 2 Leakage Current (VG2S = ±6.0 Vdc, VG1S = 0, VDS = 0) | lG2SS | | | 20 | nAdc |
| Gate 1 to Source Cutoff Voltage (VDS = 15 Vdc, VG2S = 4.0 Vdc, ID = 200 μAdc) | VG1S(off) | _ | - | -4.0 | Vdc |
| Gate 2 to Source Cutoff Voltage ($V_{DS} = 15 \text{ Vdc}$, $V_{G1S} = 0$, $I_{D} = 200 \mu \text{Adc}$) | VG2S(off) | _ | | -4.0 | Vdc |
| ON CHARACTERISTICS | | | · | | <u> </u> |
| Zero-Gate-Voltage Drain Current (VDS = 15 Vdc, VG2S = 0, VG2S = 4.0 Vdc) | IDSS | 3.0 | 10 | 30 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | · | | |
| Forward Transfer Admittance (Gate 1 connected to Drain) (VDS = 15 Vdc, VG2S = 4.0 Vdc, ID = 10 mAdc, f = 1.0 kHz) | lYfsl | 10 | _ | 20 | mmhos |
| Input Capacitance (VDS = 15 Vdc, VG2S = 4.0 Vdc, ID = IDSS, f = 1.0 MHz) | Ciss | | 4.5 | 7.0 | pF |
| Reverse Transfer Capacitance (VDS = 15 Vdc, VG2S = 4.0 Vdc, ID = IDSS, = 1.0 MHz) | C _{rss} | - | 0.023 | 0.05 | pF |
| Output Capacitance (VDS = 15 Vdc, VG2S = 4.0 Vdc, ID = IDSS, f = 1.0 MHz) | Coss | _ | 2.5 | 4.0 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | | L |
| Noise Figure (Figure 8) (See Test Circuit in Figure 11) | NF | _ | 2.5 | 3.5 | dB |
| Common Source Power Gain (Figure 7) (See Test Circuit in Figure 11) | Gps | 20 | 23 | _ | dΒ |
| Level of Unwanted Signal for 1.0% Cross Modulation (Figure 10) (See Test Circuit in Figure 11) | | | 45 | _ | mV |

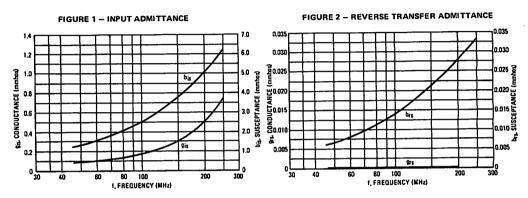
(See Test Circuit in Figure 11)

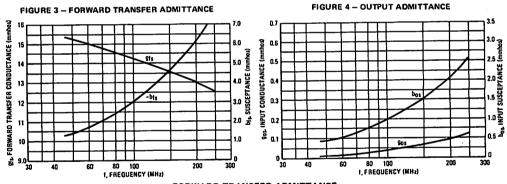
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

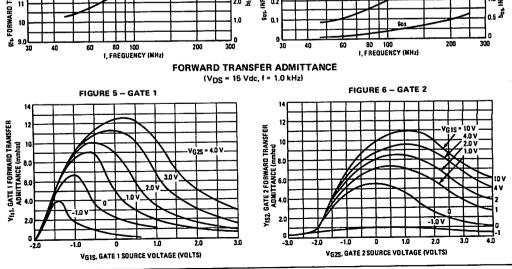
| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------------|-----|------|-----|------|
| Common-Source Conversion Power Gain (Gate 1 or Gate 2 Injection, Figure 12) (See Test Circuit in Figure 13) (Signal Frequency = 100 MHz, Local Oscillator Frequency = 110.7 MHz) | G _C | 15 | 18.5 | _ | d₿ |
| 1/2 l.F. Rejection (See Test Circuit in Figure 13) | 1/2 IFREJ | _ | 50 | _ | dB |

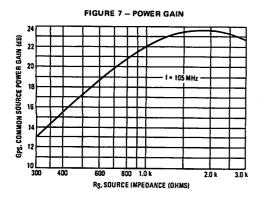
COMMON-SOURCE ADMITTANCE PARAMETERS

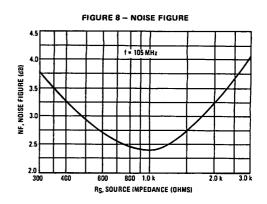
(VDS = 15 Vdc, VG2S = 4.0 Vdc, ID = 6.0 mAdc)

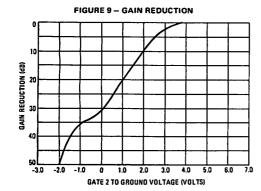


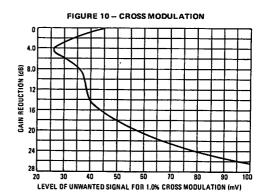


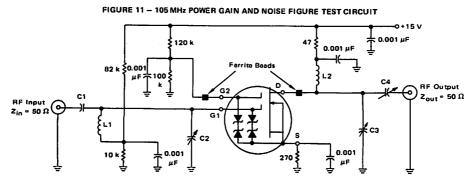












The following component values are for a <u>stern</u> stability factor = 2.0.
L1,L2 128 nH PAUL SMITH CO. SK-138-1
4-% Turns (yellow)

C1 Nominal 7.0 pF Adjusted for source impedance of approximately 1000 Ω, JOHANSON JMC2951

- C2 Nominal 4.0 pF ARCO 402
- C3 Nominal 13.73 pF ARCO 403
- C4 Nominal 4.36 pF JOHANSON JMC2951
- All Decoupling Capacitors are Ceramic Discs.

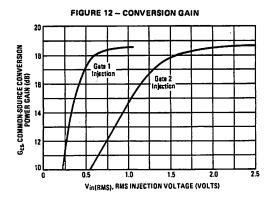
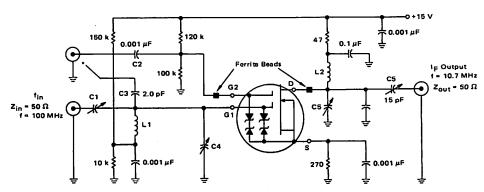


FIGURE 13 - CONVERSION GAIN TEST CIRCUIT

Local Oscillator Injection V_{in(RMS)} ≈ 2.0 V for G2 ≈ 0.9 V for G1 f = 110.7 MHz



L1 126 nH PAUL SMITH CO. SK-138-1 4-% Turns (yellow)

L2 2.73 µH High Unloaded Q C1 JOHANSON JMC2981

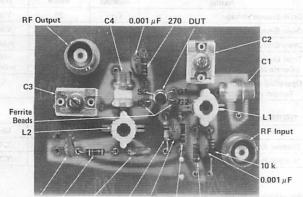
C4,C5,C8 ARCO 402

*For G1 injection, C2 is changed to bypass G2 to ground and C3 is added to connect G1 to the injection input.

PRINTED CIRCUIT BOARD LAYOUT INFORMATION

FIGURE 14 - TEST FIXTURES

105 MHz POWER GAIN AND NOISE FIGURE TEST CIRCUIT

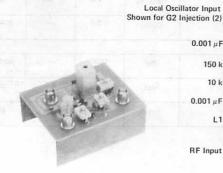


0.001 µF 47 0.001 µF 100 k 0.001 µF 120 k 82 k



100 MHz to 10.7 MHz CONVERSION GAIN TEST CIRCUIT

> 100 k 120 k Ferrite Beads 0.1 μF 47 0.001 µF



0.001 µF C5 150 k 10 k 15 pF 0.001 µF L1 RF Input C4 DUT 270 0.001 µF C6 IF Output

Notes:
1. C1 is on the bottom side of the board.
2. For G1 Injection, C2 is changed to bypass
G2 to ground and C3 is added to connect G1 to
the injection input. See Figure 13.

MFE823

CASE 22-03, STYLE 11 TO-18 (TO-206AA)

MOSFET

P-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|-----------------------------------|-------------|-------------|
| Drain-Source Voltage | VDS | 25 | Vdc |
| Drain-Gate Voltage | VDG | ±10 | Vdc |
| Drain Current | lD | 30 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 1.71 | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +175 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|-------------------|-----|------|
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 584 | °C/W |
| Thermal Resistance, Junction to Case | R _Ø JC | 250 | °C/W |

Refer to 2N4352 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|-------|------|-------|
| OFF CHARACTERISTICS | | | | |
| Drain-Source Breakdown Voltage (I _D = -10 μAdc, V _{GS} = 0 Vdc) | V(BR)DSX | - 25 | _ | Vdc |
| Zero-Gate-Voltage Drain Current (VDS = -10 Vdc, VGS = 0) | loss | _ | - 20 | nAdc |
| Gate Reverse Current (VGS = -10 Vdc, VDS = 0) | lGSS | _ | 1.0 | pAdc |
| ON CHARACTERISTICS | | | | |
| Gate Threshold Voltage (V _{DS} = -10 Vdc, I _D = -10 μAdc) | VGS(Th) | -2.0 | -6.0 | Vdc |
| On-State Drain Current (VDS = -10 Vdc, VGS = -10 Vdc) | lD(on) | - 3.0 | _ | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Forward Transfer Admittance (V _{DS} = -10 Vdc, I _D = -2.0 mAdc, f = 1.0 kHz) | lyfsl | 1000 | | μmhos |
| Input Capacitance (Vps = -10 Vdc, Vgs = -10 Vdc, f = 1.0 MHz) | C _{iss} | | 6.0 | pF |
| Reverse Transfer Capacitance (VDS = -10 Vdc, VGS = -10 Vdc, f = 1.0 MHz) | C _{rss} | _ | 1.5 | ρF |

MFE825

CASE 22-03, STYLE 2 TO-18 (TO-206AA)

MOSFET

N-CHANNEL - DEPLETION

MAXIMUM RATINGS Symbol Unit Value **Drain-Source Voltage** VDS 20 Vdc Gate-Source Voltage Vdc VGS 30 **Drain Current** lD 25 mΑ Total Device Dissipation @ TA = 25°C P_D 200 mW Derate above 25°C mW/°C 1.6 **Junction Temperature Range** Tj 150 °C **Operating and Storage Junction** -65 to +150 °C TJ, Tstg Temperature Range

Refer to 2N3796 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|----------|-----|-------|-------|
| OFF CHARACTERISTICS | | | • | |
| Drain-Source Breakdown Voltage (I _D = 1.0 μA, V _{GS} = -8.0 V) | V(BR)DSX | 20 | _ | Vdc |
| Gate Reverse Current (VGS = -10 V, VDS = 0 V) | IGSS | | -1.0 | pΑ |
| Gate Source Voltage (I _D = 1.0 µA, V _{DS} = 2.0 V) | VGS | 0 | - 2.0 | Vdc |
| ON CHARACTERISTICS | _ | | | |
| Zero-Gate-Voltage Drain Current (Vps = 10 V, Vgs = 0) | loss | 1.0 | 25 | mA |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Forward Transfer Admittance (Vps = 10 V, Vgs = 0, f = 1.0 kHz) | lyfsl | 500 | _ | μmhos |

MFE910 MPF910

MFE910 CASE 79-02, STYLE 6 TO-39 (TO-205AD)

MPE910 CASE 29-03, STYLE 22 (TO-226AE)

> TMOS SWITCHING

N-CHANNEL -- ENHANCEMENT

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|-----------------------|-------------|----------------|
| Drain-Source Voltage | VDS | 60 | Vdc |
| Gate-Source Voltage | VGS | ±15 | Vd¢ |
| Drain Current — Continuous(1) Pulsed(2) | l _D MQl | 0.5 1.0 | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C MPF910 | PD | 1.0 8.0 | Watts mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C MFE910 | PD | 6.25 50 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | °C |

⁽¹⁾ The Power Dissipation of the package may result in a lower continuous drain current.

Refer to 2N6659 for additional graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|---------------------|-----|------|-----|-------|
| OFF CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current (VDS = 40 V, VGS = 0) | loss | _ | 0.1 | 10 | μAdc |
| Gate Reverse Current (VGS = 10 V, VDS = 0) | IGSS | - | 0.01 | 10 | nAdc |
| Drain-Source Breakdown Voltage (VGS = 0, ID = 100 μ A) | V(BR)DSS | 60 | 90 | _ | Vdc |
| ON CHARACTERISTICS | | | | | |
| Gate Threshold Voltage (Vps = Vgs, lp = 1.0 mA) | VGS(th) | 0.3 | 1.5 | 2.5 | Vdc |
| Drein-Source On-Voltage (VGS = 10 V, ID = 500 mA) | V _{DS(on)} | | _ | 2.5 | Vdc |
| On-State Drain Current (VDS = 25 V, VGS = 10 V) | ^I D(on) | 500 | _ | _ | mA |
| Forward Transconductance (VDS = 15 V, ID = 500 mA) | 9fs | 100 | _ | _ | mmhos |



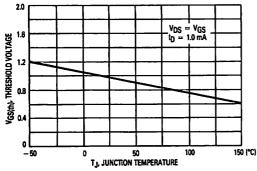
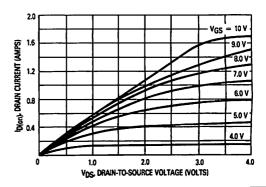


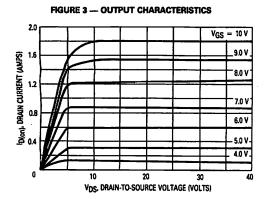
FIGURE 2 - ON-REGION CHARACTERISTICS

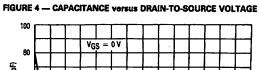


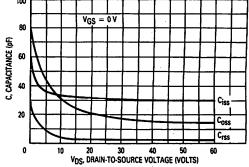
SMALL-SIGNAL DEVICES

⁽²⁾ Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

MFE910, MPF910







MFE930 MFE960 MFE990

CASE 79-02, STYLE 6 TO-39 (TO-205AD)

TMOS SWITCHING

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

| Rating | Symbol | MFE930 | MFE960 | MFE990 | Unit |
|--|-----------------------------------|------------|--------|--------|----------------|
| Drain-Source Voltage | VDS | 35 | 60 | 90 | Vdc |
| Drain-Gate Voltage | V _{DG} | 35 | 60 | 90 | Vdc |
| Gate-Source Voltage | VGS | ±30 | | | Vdc |
| Drain Current Continuous(1) Pulsed(2) | I _D | 2.0 3.0 | | | Adc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 6.25 50 | | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | 55 to 150 | | | °C |

- (1) The Power Dissipation of the package may result in a lower continuous drain current.
- (2) Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|----------------------------|---------------------|----------------|-------------------|-------------------|------|
| OFF CHARACTERISTICS | | | | | | |
| Drain-Source Breakdown Voltage (VGS = 0, I _D = 10 μA) | MFE930 MFE960 MFE990 | V(BR)DSX | 35 60 90 | _ _ _ | _ | Vdc |
| Gate Reverse Current (VGS = 15 Vdc, VDS = 0) | | ^I GSS | _ | _ | 50 | nAdc |
| ON CHARACTERISTICS* | | | | | | |
| Zero-Gate-Voltage Drain Current (VDS = Maximum Rating, VGS = 0) | | loss | 1 | _ | 10 | μAdc |
| Gate Threshold Voltage (VDS = VGS, ID = 1.0 mA) | | V _{GS(Th)} | 1.0 | _ | 3.5 | Vdc |
| Drain-Source On-Voltage (V _{GS} = 10 V) (I _D = 0.5 A) | MFE930 MFE960 MFE990 | V _{DS(on)} | _ | 0.4 0.6 0.6 | 0.7 0.8 1.0 | Vdc |
| (I _D = 1.0 A) | MFE930 MFE960 MFE990 | | Ξ | 0.9 1.2 1.2 | 1.4 1.7 2.0 | |
| (I _D = 2.0 A) | MFE930 MFE960 MFE990 | | = | 2.2 2.8 2.8 | 3.0 3.5 4.0 | |
| Static Drain-Source On Resistance (VGS = 10 Vdc, I _D = 1.0 Adc) | MFE930 MFE960 MFE990 | fDS(on) | = | 0.9 1.2 1.2 | 1.4 1.7 2.0 | Ohms |
| On-State Drain Current (VDS = 25 V, VGS = 10 V) | | lD(on) | 1.0 | 2.0 | _ | Amps |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Input Capacitance (V _{DS} = 25 V, V _{GS} = 0, f = 1.0 MHz) | | C _{iss} | _ | 60 | 70 | pF |
| Reverse Transfer Capacitance (V _{DS} = 25 V, V _{GS} = 0, f = 1.0 MHz) | | C _{rss} | _ | 13 | 18 | pF |
| Output Capacitance (V _{DS} = 25 V, V _{GS} = 0, f = 1.0 MHz) | | Coss | _ | 49 | 60 | pF |

MFE930, MFE960, MFE990

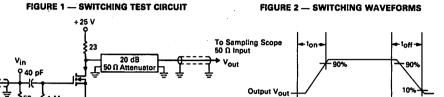
Pulse Generator

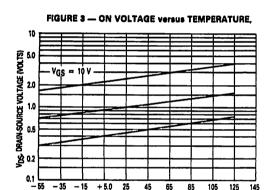
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|--------|-----|-----|-----|-------|
| Forward Transconductance (V _{DS} = 25 V, I _D = 0.5 A) | 9fs | 200 | 380 | _ | mmhos |
| SWITCHING CHARACTERISTICS* | | | • | | |
| Turn-On Time (See Figure 1) | ton | _ | 7.0 | 15 | ns |
| Turn-Off Time (See Figure 1) | toff | _ | 7.0 | 15 | กร |

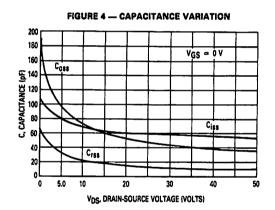
^{*}Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

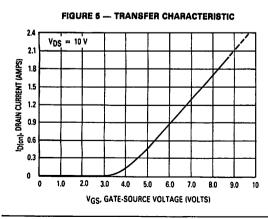
RESISTIVE SWITCHING





TJ, JUNCTION TEMPERATURE (°C)





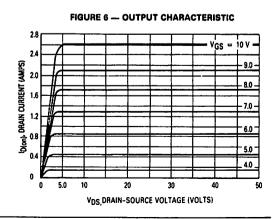
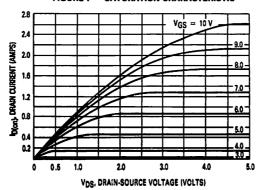


FIGURE 7 — SATURATION CHARACTERISTIC



MFE2000

CASE 20-03, STYLE 1 TO-72 (TO-206AF)

JFET VHF/UHF AMPLIFIER

N-CHANNEL - DEPLETION

MFE2001

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|-------------|
| Drain-Source Voltage | VDS | 25 | . Vdc |
| Drain-Gate Voltage | VDG | 25 | Vdc |
| Gate-Source Voltage | VGS | - 25 | Vdc |
| Drain Current | lD | 30 | mAdc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 300 2.0 | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +175 | ℃ |

Refer to 2N4416 for graphs.

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|--------------------|------------------|--------------|------------|--------------|--------------|
| OFF CHARACTERISTICS | | | | | | |
| Gate-Source Breakdown Voltage (I _G = -1.0 μAdc, V _{DS} = 0) | | V(BR)GSS | - 25 | _ | _ | Vdc |
| Gate Reverse Current (VGS = -20 Vdc, VDS = 0) (VGS = -20 Vdc, VDS = 0, TA = 150°C) | | IGSS | - | = | -100 -200 | pAdc nAdc |
| Gate Source Cutoff Voltage (I _D = 0.5 mAdc, V _{DS} = 15 Vdc) | MFE2000 MFE2001 | VGS(off) | -0.5 -2.0 | _ | -4.0 -6.0 | Vdc |
| ON CHARACTERISTICS | | | | | | |
| Zero-Gate-Voltage Drain Current (V _{DS} = 15 Vdc, V _{GS} = 0) | MFE2000 MFE2001 | IDSS | 4.0 8.0 | _ | 10 20 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Forward Transfer Admittance (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz) | MFE2000 MFE2001 | lYfsl | 2500 4000 | _ | 6000 8000 | μmhos |
| Output Admittance (Vps = 15 Vdc, V _{GS} = 0, f = 1.0 kHz) | MFE2000 MFE2001 | lyosi | - | <u>-</u> | 50 76 | μmhos |
| Input Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz) | | Ciss | _ | _ | 5.0 | pF |
| Reverse Transfer Capacitance (VDS = 15 Vdc, VGS = 0, f = 1.0 MHz) | | C _{rss} | _ | - | 1.0 | pF |
| Output Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz) | | Coss | _ | - | 2.0 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | | _ | |
| Noise Figure (Vps = 15 Vdc, Ip = 4.0 mAdc, f = 100 MHz, Rg (Vps = 15 Vdc, Ip = 4.0 mAdc, f = 400 MHz, Rg | | NF | _ | 1.6 3.3 | 2.0 4.0 | dB |
| Common Source Power Gain (Vps = 15 Vdc, lp = 4.0 mAdc, f = 100 MHz) (Vps = 15 Vdc, lp = 4.0 mAdc, f = 400 MHz) | | G _{ps} | 18 10 | 23 14 | = | dB |

MFE2004 MFE2005 MFE2006

CASE 22-03, STYLE 4 TO-18 (TO-206AA)

JFET CHOPPER

N-CHANNEL - DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|------------------|-------------|----------------|
| Drain-Source Voltage | VDS | 30 | Vdc |
| Drain-Gate Voltage | VDG | 30 | Vdc |
| Gate-Source Voltage | VGS | 30 | Vdc . |
| Forward Gate Current | lGF | 10 | mAdc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.8 10 | Watts mW/°C |
| Junction Temperature Range | TJ | -65 to +175 | °C |
| Storage Temperature Range | T _{stg} | -65 to +200 | °C |

Refer to 2N4091 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|-------------------------------|---------------------|-------------------|-------------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (IG = 1.0 μAdc, VDS = 0) | | V(BR)GSS | 30 | - | Vdc |
| Gate Reverse Current (VGS = 20 Vdc, VDS = 0) (VGS = 20 Vdc, VDS = 0, TA = 150°C) | | ¹ GSS | | 0.2 0.4 | nAdc μAdc |
| Drain Cutoff Current (VDS = 20 Vdc, VGS = 12 Vdc) (VDS = 20 Vdc, VGS = 12 Vdc, TA = 150°C) | | ^I D(off) | <u>-</u> | 0.2 0.4 | nAdc µAdc |
| Gate Source Voltage (V _{DS} = 20 Vdc, I _D = 50 μAdc) | MFE2004 MFE2005 MFE2006 | V _{GS} | 1.0 2.0 5.0 | 6.0 8.0 10 | Vdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current* (VDS = 20 Vdc, VGS = 0) | MFE2004 MFE2005 MFE2006 | loss* | 8.0 15 30 | _ _ _ | mAdc |
| Gate-Source Forward Voltage (IG = 1.0 mAdc, VDS = 0) | | VGS(f) | | 1.0 | Vdc |
| Drain-Source On-Voltage (ID = 3.0 mAdc, VGS = 0) (ID = 6.0 mAdc, VGS = 0) (ID = 10 mAdc, VGS = 0) | MFE2004 MFE2005 MFE2006 | VDS(on) | = | 0.4 0.4 0.4 | Vdc |
| Static Drain-Source On Resistance (ID = 1.0 mAdc, VGS = 0) | MFE2004 MFE2005 MFE2006 | rDS(on) | - - - | 80 50 30 | Ohms |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Static Drain-Source "ON" Resistance (VGS = 0, I _D = 0, f = 1.0 kHz) | MFE2004 MFE2005 MFE2006 | ^r ds(on) | <u>-</u> - | 80 50 30 | Ohms |
| Input Capacitance (VDS = 0, VGS = -12 Vdc, f = 1.0 MHz) | | C _{iss} | _ | 16 | pF |

MFE2004, MFE2005, MFE2006

| Characteristic | | Symbol | Min | Max | Unit |
|--|---------|--------|-----|-----|------|
| Reverse Transfer Capacitance | | Crss | | | pF |
| $(V_{DS} = 0, V_{GS} = 6.0 \text{ Vdc, f} = 1.0 \text{ MHz})$ | MFE2004 | "" | _ | 5.0 | \ |
| (VDS = 0, VGS = 8.0 Vdc, f = 1.0 MHz) | MFE2005 | | | 5.0 | Ì |
| (VDS = 0, VGS = 12 Vdc, f = 1.0 MHz) | MFE2006 | | - | 5.0 | |
| SWITCHING CHARACTERISTICS | | | | | |
| Turn-On Delay Time | | td(on) | | | ns |
| $(V_{DD} = 3.0 \text{ Vdc}, I_{D} = 3.0 \text{ mAdc}, V_{GS} = 0)$ | MFE2004 | | _ | 20 | • |
| $(V_{DD} = 3.0 \text{ Vdc}, I_{D} = 6.0 \text{ mAdc}, V_{GS} = 0)$ | MFE2005 | | _ | 15 | |
| $(V_{DD} = 3.0 \text{ Vdc}, I_{D} = 10 \text{ mAdc}, V_{GS} = 0)$ | MFE2006 | | | 10 | |
| Rise Time | | tr | | | ns |
| $(V_{DD} = 3.0 \text{ Vdc, ID} = 3.0 \text{ mAdc, VGS} = 0)$ | MFE2004 | , i | _ | 40 | 1 |
| $(V_{DD} = 3.0 \text{ Vdc}, I_{D} = 6.0 \text{ mAdc}, V_{GS} = 0)$ | MFE2005 | | _ | 20 | |
| (VDD = 3.0 Vdc, iD = 10 mAdc, VGS = 0) | MFE2006 | | _ | 10 | |
| Turn-Off Time | | toff | | | ns |
| (VDD = 3.0 Vdc, ID = 3.0 mAdc, VGS(off) = 6.0 Vdc) | MFE2004 | "" | _ | 80 | |
| (VDD = 3.0 Vdc, ID = 6.0 mAdc, VGS(off) = 8.0 Vdc) | MFE2005 | | _ | 60 | |
| (VDD = 3.0 Vdc, ID = 10 mAdc, VGS(off) = 12 Vdc) | MFE2006 | | _ | 40 | |

^{*}Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 3.0%.

MFE2010 MFE2011 MFE2012

CASE 22-03, STYLE 4 TO-18 (TO-206AA)

JFET CHOPPER

N-CHANNEL - DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|---------------|
| Drain-Source Voltage | VDS | 25 | Vdc |
| Drain-Gate Voltage | VDG | 25 | Vdc |
| Gate-Source Voltage | VGS | 25 | Vdc |
| Forward Gate Current | IGF | 50 | mAdc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.8 10 | Watt mW/°C |
| Junction Temperature Range | TJ | -65 to +175 | °C |
| Storage Temperature Range | T _{stg} | -65 to +200 | ပ္ |

Refer to J107 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------|---------------------|-----|---------------------------------------|--------------|
| OFF CHARACTERISTICS | | | _ | | |
| Gate-Source Breakdown Voltage | | V(BR)GSS | 25 | _ | Vdc |
| (IG = 10 μAdc, VDS = 0) | | ,51,720 | | | |
| Gate Reverse Current | | IGSS | | | |
| $(V_{GS} = 15 \text{ Vdc}, V_{DS} = 0)$ | | | _ | 3.0 | nAdc |
| (V _{GS} = 15 Vdc, V _{DS} = 0, T _A = 150°C) | | | | 6.0 | μAdc |
| Drain Cutoff Current | | ¹ D(off) | | | |
| (VDS = 15 Vdc, VGS = 12 Vdc) | | | _ | 3.0 | nAdc |
| (V _{DS} = 15 Vdc, V _{GS} = 12 Vdc, T _A = 150°C) | | | | 6.0 | μAdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current* | | lpss* | | | mAdc |
| (V _{DS} = 20 Vdc, V _{GS} = 0) | MFE2010 | | 15 | _ | |
| | MFE2011 | | 40 | _ | ł |
| | MFE2012 | | 100 | _ | |
| Gate-Source Forward Voltage | | V _{GS(f)} | _ | 1.0 | Vdc |
| (IG = 1.0 mAdc, V _{DS} = 0) | | | | | <u> </u> |
| Gate-Source Voltage | | V _{GS} │ | | | Vdc |
| (V _{DS} = 15 Vdc, I _D = 1.0 μAdc) | MFE2010 | | 0.5 | 10 | ł |
| | MFE2011 | 1 1 | 1.0 | 10 | |
| | MFE2012 | | 3.0 | 10 | |
| Drain-Source On-Voltage | | VDS(on) | | 1 | Vdc |
| (ID = 8.0 mAdc, VGS = 0) | MFE2010 | 1 1 | _ | 0.75 | 1 |
| (ID = 15 mAdc, VGS = 0) | MFE2011 | 1 1 | _ | 0.75 | ł |
| (ID = 30 mAdc, VGS = 0) | MFE2012 | | | 0.75 | \ |
| Static Drain-Source On Resistance | | rDS(on) | | | Ohms |
| (ID = 1.0 mAdc, VGS = 0) | MFE2010 | | _ | 25 | i |
| | MFE2011 MFE2012 | | _ | 15 | ĺ |
| Ottobal Cloud Class Company | MFE2012 | | | 10 | L |
| SMALL-SIGNAL CHARACTERISTICS | | | | · · · · · · · · · · · · · · · · · · · | , |
| Static Drain-Source "ON" Resistance (VGS = 0, ID = 0, f = 1.0 kHz) | | rds(on) | | | Ohms |
| | MFE2010 | 1 1 | _ | 25 | |
| | MFE2011 MFE2012 |]] | _ | 15 10 | |
| Innut Considered | WII E2012 | | | | |
| Input Capacitance (Vps = 0, Vgs = 10 Vdc, f = 1.0 MHz) | | C _{iss} | _ | 50 | pF |
| | | - - | | | |
| Reverse Transfer Capacitance | | C _{rss} | _ | 20 | pF |
| (V _{DS} = 0, V _{GS} = 12 Vdc, f = 1.0 MHz) | | | | | I |

MFE2010, MFE2011, MFE2012

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|--|-------------------------------|---------------------|-----|----------------|------|
| SWITCHING CHARACTERISTICS | | | | | |
| Turn-On Delay Time | | td(on) | 1 | 10 | ns |
| Rise Time | | t _r | 1 | 6.0 | ns |
| Turn-Off Delay Time (VDD = 15 Vdc, ID = 8.0 mAdc) (VDD = 15 Vdc, ID = 15 mAdc) (VDD = 15 Vdc, ID = 30 mAdc) | MFE2010 MFE2011 MFE2012 | ^t d(off) | 111 | 35 20 12 | ns |
| Fall Time (V _{DD} = 15 Vdc, I _D = 8.0 mAdc) (V _{DD} = 15 Vdc, I _D = 15 mAdc) (V _{DD} = 15 Vdc, I _D = 30 mAdc) | MFE2010 MFE2011 MFE2012 | tf | 111 | 75 45 25 | ns |

^{*}Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 3.0%.

CASE 20-03, STYLE 2 TO-72 (TO-206AF)

FET LOW-POWER AUDIO

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

| MAXIMON INTINGO | | | |
|---|-------------------|-------------|-------------|
| Rating | Symbol | Value | Unit |
| Drain-Source Voltage | V _{DS} _ | 20 | Vdc |
| Drain-Gate Voltage | V _{DG} | ±20 | Vdc |
| Drain Current | Ql | 20 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 200 1.14 | mW mW/°C |
| Junction Temperature Range | TJ | + 200 | ° C |
| Storage Temperature Range | T _{stg} | -65 to +175 | င္ |

Refer to 2N3796 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|-----|------|-------|
| OFF CHARACTERISTICS | | | | |
| Drain-Source Breakdown Voltage (VGS = -8.0 V, I _D = 10 μAdc) | V(BR)DSX | 20 | _ | Vdc |
| Gate Reverse Current (VGS = -10 Vdc, V _{DS} = 0) | IGSS | 1 | 10 | pAdc |
| Gate Source Cutoff Voltage (Ips = 1.0 μAdc, Vps = 10 Vdc) | VGS(off) | - | -8.0 | Vdc |
| ON CHARACTERISTICS | | | | |
| Zero-Gate-Voltage Drain Current (VGS = 0 Vdc, VDS = 10 Vdc) | IDSS | 0.5 | 6.0 | mAdc |
| On-State Drain Current (VGS = 3.5 Vdc, VDS = 10 Vdc) | ID(on) | 5.0 | - | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Forward Transfer Admittance (VDS = 10 Vdc, VGS = 0, f = 1.0 kHz) | lYfsl | 700 | 3500 | μmhos |
| Output Admittance (V _{DS} = 10 Vdc, V _{GS} = 0, f = 1.0 kHz) | lyosl | _ | 100 | μmhos |
| Input Capacitance (VDS = 10 Vdc, VGS = 0, f = 1.0 MHz) | C _{iss} | _ | 5.0 | ρF |
| Reverse Transfer Capacitance (VDS = 10 Vdc, VGS = 0, f = 1.0 MHz) | C _{rss} | _ | 1.5 | pF |

CASE 20-03, STYLE 7 TO-72 (TO-206AF)

MOSFET CHOPPER

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|-------------|
| Drain-Source Voltage | VDS | 15 | Vdc |
| Drain-Gate Voltage | VDG | 20 | Vdc |
| Gate-Source Voltage | VGS | ±20 | Vdc |
| Drain Current | ^I D | 30 | mAdc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 200 1.4 | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +175 | ° |

| Characteristic | Symbol | Min | Max | Unit |
|---|---------------------|-----|-----------|------|
| OFF CHARACTERISTICS | | | | |
| Zero-Gate-Voltage Drain Current (Vps = +10 Vdc, Vgs = 0) (Vps = +10 Vdc, Vgs = 0, Tc = 125°C) | IDSS | _ | 10 100 | nAdc |
| Gate Reverse Current (VGS = ±10 Vdc, VDS = 0) | 'GSS | - | ± 100 | pAdc |
| Drain-Source Breakdown Voltage (VGS = 0, ID = 10 µAdc) | V(BR)DS | 15 | _ | Vdc |
| ON CHARACTERISTICS | | | | |
| Gate Threshold Voltage (Vps = +10 Vdc, lp = 10 μAdc) | VGS(TH) | _ | 3.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Input Capacitance (Vps = +10 Vdc, Vgs = 0, f = 1.0 MHz) | C _{iss} | _ | 5.0 | pF |
| Reverse Transfer Capacitance (Vps = 0, Vgs = 0, f = 1.0 MHz) | C _{rss} | _ | 1.0 | pF |
| Drain-Substrate Capacitance (VD(SUB) = +10 Vdc, f = 1.0 MHz) | C _{d(sub)} | _ | 4.0 | pF |
| Static Drain-Source On Resistance (VGS = +10 Vdc, Ip = 0, f = 1.0 kHz) | ^r ds(on) | _ | 100 | Ohms |

CASE 20-03, STYLE 5 TO-72 (TO-206AF)

MOSFET CHOPPER

P-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|-----------------------------------|-------------|-------------|
| Drain-Source Voltage | VDS | - 15 | Vdc |
| Drain-Gate Voltage | V _{DG} | ±20 | Vdc |
| Gate-Source Voltage | VGS | ±20 | Vdc |
| Drain Current | l _D | 30 | mAdc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 200 1.33 | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +175 | ဇ |

| Characteristic | Symbol | Min | Max | Unit |
|---|---------------------|------|-------------|------|
| OFF CHARACTERISTICS | | | | |
| Drain-Source Breakdown Voltage (VGS = 0, I _D = -10 μAdc) | V(BR)DSX | - 15 | - | Vdc |
| Zero-Gate-Voltage Drain Current (VDS = -10 Vdc, VGS = 0) (VDS = -10 Vdc, VGS = 0, TC = 125°C) | IDSS | | -10 -100 | nAdc |
| Gate Reverse Current (VGS = ±10 Vdc, VDS = 0) | IGSS | _ | ±100 | pAdc |
| ON CHARACTERISTICS | | | | |
| Gate Threshold Voltage (Vps = -10 Vdc, lp = -10 μAdc) | VGS(Th) | _ | -4.0 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Drain-Source Resistance (VGS = -10 Vdc, ID = 0, f = 1.0 kHz) | ^r ds(on) | _ | 200 | Ohms |
| Input Capacitance (VDS = -10 Vdc, VGS = 0, f = 1.0 MHz) | C _{iss} | _ | 4.0 | pF |
| Reverse Transfer Capacitance (Vps = 0, Vgs = 0, f = 1.0 MHz) | C _{rss} | _ | 1.0 | pF |
| Drain-Substrate Capacitance (Vp(SUB) = -10 Vdc, f = 1.0 MHz) | C _{d(sub)} | - | 2.0 | pF |

MFE3004 MFE3005

CASE 20-03, STYLE 7 TO-72 (TO-206AF)

MOSFET VHF/UHF AMPLIFIER

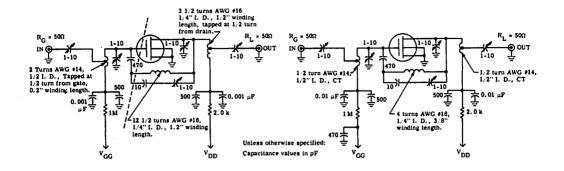
N-CHANNEL — DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|-------------|
| Drain-Source Voltage | V _{DS} | 20 | Vdc |
| Drain-Gate Voltage | V _{DG} | 20 | Vdc |
| Gate-Source Voltage | VGS | ±20 | Vdc |
| Drain Current | l _D | 10 | mAdc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 200 1.33 | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +175 | °C |

| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|------|------|-------|
| OFF CHARACTERISTICS | | | | |
| Drain-Source Breakdown Voltage (VGS = −5.0 Vdc, I _D = 10 µAdc) | V(BR)DSX | 20 | - | Vdc |
| Gate Reverse Current (VGS = ±15 Vdc, VDS = 0) | IGSS | _ | ± 50 | pAdc |
| Gate Source Cutoff Voltage (I _D = 10 μAdc, V _{DS} = 15 Vdc) | VGS(off) | _ | -5.0 | Vdc |
| ON CHARACTERISTICS | | | | |
| Zero-Gate-Voltage Drain Current (VDS = 15 Vdc, VGS = 0) | l _{DSS} | 2.0 | 10 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Forward Transfer Admittance ($V_{DS} = 15 \text{ Vdc}$, $I_D = 2.0 \text{ mAdc}$, $f = 1.0 \text{ kHz}$) | lYfsl | 2000 | _ | μmhos |
| Input Capacitance (V _{DS} = 15 Vdc, V _{GS} = 0, f = 1.0 MHz) | C _{iss} | _ | 4.5 | pF |
| Reverse Transfer Capacitance (Vps = 15 Vdc, Vgs = 0, f = 1.0 MHz) | C _{rss} | _ | 0.4 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | |
| Noise Figure (Vps = 15 Vdc, lp = 2.0 mAdc, Rs ≈ 1.8 k ohms, f = 200 MHz) (Figure 1) MFE3004 | NF | | 4.5 | dB |
| (V _{DS} = 15 Vdc, I _D = 2.0 mAdc, R _S ≈ 650 ohms, f = 400 MHz) (Figure 2) MFE3005 | | _ | 4.5 | |
| Common Source Power Gain | Gps | | | dB |
| (V _{DS} = 15 Vdc, I _D = 2.0 mAdc, R _S ~ 1.8 k ohms, f = 200 MHz) (Figure 1) MFE3004 | | 16 | _ | |
| (V _{DS} = 15 Vdc, ! _D = 2.0 mAdc, R _S ≈ 650 ohms, f = 400 MHz) (Figure 2) MFE3005 | | 10 | _ | |

FIGURE 1 - 200 MHz TEST CIRCUIT - NEUTRALIZED



CASE 22-03, STYLE 12 TO-18 (TO-206AA)

TMOS SWITCHING

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|----------------------|-------------|----------------|
| Drain-Source Voltage | V _{DS} | 200 | Vdc |
| Gate-Source Voltage | VGS | ±20 | Vdc |
| Drain Current Continuous (1) Pulsed (2) | I _D | 400 800 | mAdc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.8 14.4 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | °C |

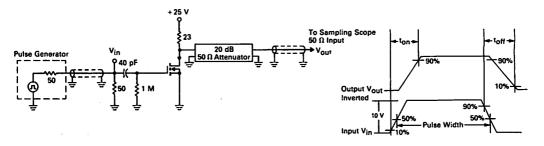
ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.) Characteristic Symbol Min Тур Max Unit **OFF CHARACTERISTICS** Drain-Source Breakdown Voltage V(BR)DSX 200 Vdc $(V_{GS} = 0, I_{D} = 10 \mu A)$ **Gate Reverse Current** 0.01 50 nAdc IGSS (VGS = 15 Vdc, VDS = 0) ON CHARACTERISTICS* Zero-Gate-Voltage Drain Current loss 0.1 **µAdc** $(V_{DS} = 200 \text{ V}, V_{GS} = 0)$ Gate Threshold Voltage VGS(Th) 1.0 Vdc $(V_{DS} = V_{GS}, I_{D} = 1.0 \text{ mA})$ Drain-Source On-Voltage (VGS = 10 V) V_{DS(on)} Vdc $(l_D = 100 \text{ mA})$ 0.45 0.6 $(l_{D} = 250 \text{ mA})$ 1.20 1.60 (ID = 500 mA) 3.0 Static Drain-Source On Resistance Ohms rDS(on) (VGS = 10 Vdc) $(l_D = 100 \text{ mA})$ 4.5 6.0 (ID = 250 mA) 4.8 6.4 $(l_D = 500 \text{ mA})$ 6.0 **On-State Drain Current** 400 ID(on) 700 mΑ $(V_{DS} = 25 \text{ V}, V_{GS} = 10 \text{ V})$ **SMALL-SIGNAL CHARACTERISTICS** Input Capacitance Ciss 72 90 $(V_{DS} = 25 \text{ V}, V_{GS} = 0, f = 1.0 \text{ MHz})$ Reverse Transfer Capacitance Crss 2.8 3.5 ρF $(V_{DS} = 25 \text{ V}, V_{GS} = 0, f = 1.0 \text{ MHz})$ **Output Capacitance** Coss 15 20 pF (VDS = 25 V, VGS = 0, f = 1.0 MHz) Forward Transconductance 9fs 200 400 mmhos $(V_{DS} = 25 \text{ V}, I_{D} = 250 \text{ mA})$ **SWITCHING CHARACTERISTICS** Turn-On Time 6.0 15 ton ns See Figure 1 **Turn-Off Time** 15 toff ns See Figure 1

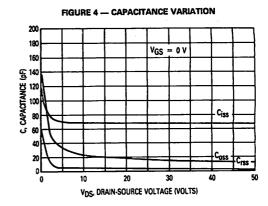
^{*} Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

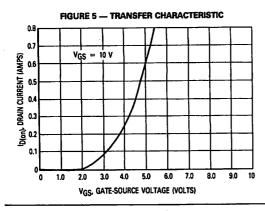
RESISTIVE SWITCHING

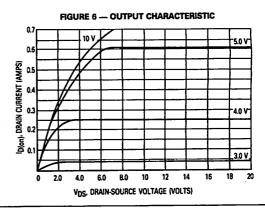
FIGURE 1 - SWITCHING TEST CIRCUIT

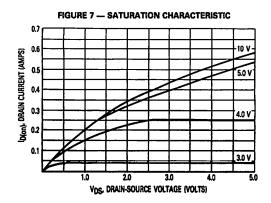
FIGURE 2 - SWITCHING WAVEFORMS











MFQ930C MFQ960C MFQ990C

CASE 632-02, STYLE 1 TO-116

> QUAD DUAL-IN-LINE TMOS

N-CHANNEL - ENHANCEMENT

MAXIMUM RATINGS

| MAXIMON INTINGO | | | | | |
|--|--------------------|----------------------|--------------------|-----------------|----------------|
| Rating | Symbol | MFQ930C | MFQ960C | MFQ990C | Unit |
| Drain-Source Voltage | VDS | 35 | 60 | 90 | Vdc |
| Drain-Gate Voltage | VDG | 35 | 60 | 90 | Vdc |
| Gate-Source Voltage | VGS | | ±30 | | Vdc |
| Drain Current Continuous (1) Pulsed (2) | i _D | | 2.0 3.0 | | Adc |
| | | | Each Transistor | Total Device | |
| Total Device Dissipation @ Total Device Dissipat | ₄ = 25℃ | PD | 0.5 17.0 | 2.0 66.6 | Watts mW/°C |
| Operating and Storage Juncti Temperature Range | ion | TJ, T _{stg} | -55 to | + 150 | °C |

Refer to MFE930 for graphs.

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|-------------------------------|---------------------|----------------|-------------------|-------------------|--------------|
| OFF CHARACTERISTICS | | | | | | |
| Drain-Source Breakdown Voltage (VGS = 0, I _D = 10 μA) | MFQ930C MFQ960C MFQ990C | V(BR)DSX | 35 60 90 | 111 | | Vdc |
| Gate Reverse Current (VGS = 15 Vdc, VDS = 0) | 0000 | lgss | _ | _ | 50 | nAdc |
| ON CHARACTERISTICS* | | | _ | | | |
| Zero-Gate-Voltage Drain Current (VDS = Maximum | Rating, VGS = 0) | IDSS | _ | _ | 10 | μAdc |
| Gate Threshold Voltage (Ip = 1.0 mA, Vps = Vgs) | | V _{GS(Th)} | 1.0 | _ | 3.5 | Vdc |
| Drain-Source On-Voltage (VGS = 10 V) (ID = 0.5 A) | MFQ930C MFQ960C MFQ990C | V _{DS(on)} | = | 0.4 0.6 0.6 | 0.7 0.8 1.0 | Vdc |
| (I _D = 1.0 A) | MFQ930C MFQ960C MFQ990C | | _ | 0.9 1.2 1.2 | 1.4 1.7 2.0 | |
| (I _D = 2.0 A) | MFQ930C MFQ960C MFQ990C | | = | 2.2 2.8 2.8 | 3.0 3.5 4.0 | |
| Static Drain-Source On Resistance (VGS = 10 Vdc, t _D = 1.0 Adc) | MFQ930C MFQ960C MFQ990C | fDS(on) | <u>-</u> | 0.9 1.2 1.2 | 1.4 1.7 2.0 | Ohms |
| On-State Drain Current (VDS = 25 V, VGS = 10 V) | | ID(on) | 1.0 | 2.0 | <u> </u> | Amps |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Input Capacitance (VDS = 25 V, VGS = 0, f = 1.0 MHz) | | C _{iss} | _ | 60 | 70 | pF |
| Reverse Transfer Capacitance (VDS = 25 V, VGS = 0, f = 1.0 MHz) | | C _{rss} | _ | 13 | 18 | pF |
| Output Capacitance (VDS = 25 V, VGS = 0, f = 1.0 MHz) | | Coss | _ | 49 | 60 | pF |
| Forward Transconductance (VDS = 25 V, ID = 0.5 A) | | 9fs | 200 | 380 | | mmhos |
| SWITCHING CHARACTERISTICS | | | | | | , |
| Turn-On Time | | ton | | 7.0 | 15 | ns |
| Turn-Off Time | | toff | _ | 7.0 | 15 | ns |

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET VHF AMPLIFIER

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|-------------|
| Drain-Source Voltage | VDS | 25 | Vdc |
| Drain-Gate Voltage | VDG | 25 | Vdc |
| Gate-Source Voltage | VGS | -25 | Vdc |
| Gate Current | IG | 10 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 200 2 | mW mW/°C |
| Junction Temperature Range | Tj | 125 | °C |
| Storage Temperature Range | T _{stq} | -65 to +150 | ℃ |

Refer to 2N4416 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|--|------------------|--------------|---------------------------------------|--|
| OFF CHARACTERISTICS | | - | | |
| Gate-Source Breakdown Voltage (IG = -10 μAdc, Vps = 0) | V(BR)GSS | -25 | _ | Vdc |
| Gate Reverse Current (V _{GS} = -15 Vdc, V _{DS} = 0) (V _{GS} = -15 Vdc, V _{DS} = 0, T _A = 100°C) | IGSS | = | -2.0 -2.0 | nAdc µAdc |
| Gate Source Cutoff Voltage (Vps = 15 Vdc, lp = 2.0 nAdc) | VGS(off) | _ | 8.0 | Vdc |
| Gate Source Voltage (Vps = 15 Vdc, lp = 0.2 mAdc) | V _{GS} | -0.5 | -7.5 | Vdc |
| ON CHARACTERISTICS | | | | |
| Zero-Gate-Voltage Drain Current* (Vps = 15 Vdc, Vgs = 0 Vdc) | IDSS | 2.0 | 20 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | · · · · · · · · · · · · · · · · · · · | ' |
| Forward Transfer Admittance* {VDS = 15 Vdc, VGS = 0, f = 1.0 kHz} (VDS = 15 Vdc, VGS = 0, f = 100 MHz} | lYfsl | 2000 1600 | 7500 — | μmhos |
| Input Admittence (VDS = 15 Vdc, VGS = 0, f = 100 MHz) | Re(yis) | . — | 800 | μmhos |
| Output Conductance (VDS = 15 Vdc, VGS = 0, f = 100 MHz) | Re(yos) | _ | 200 | μmhos |
| Input Capacitance (VDS = 15 Vdc, VGS = 0, f = 1.0 MHz) | C _{iss} | | 7.0 | pF |
| Reverse Transfer Capacitance (VDS = 15 Vdc, VGS = 0, f = 1.0 MHz) | C _{rss} | _ | 3.0 | pF |

^{*}Pulse Test: Pulse Width ≤ 630 ms; Duty Cycle ≤ 10%.

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET VHF AMPLIFIER

N-CHANNEL - DEPLETION

MAXIMUM RATINGS

| WAXINGW RATINGS | т | T | |
|--|------------------|-------------|------------|
| Rating | Symbol | Value | Unit |
| Drain-Source Voltage | VDS | 25 | Vdc |
| Drain-Gate Voltage | VDG | 25 | Vdc |
| Gate-Source Voltage | VGS | -25 | Vdc |
| Forward Gate Current | lGF | 10 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 310 2.82 | mW mW/℃ |
| Junction Temperature Range | TJ | -65 to +135 | ~℃ |
| Storage Temperature Range | T _{stq} | -65 to +150 | သိ |

Refer to 2N4416 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|---|------------------------|------|------------|--------------|
| OFF CHARACTERISTICS | | | | |
| Gate-Source Breakdown Voltage (I _G = 10 μAdc, V _{DS} = 0) | V(BR)GSS | - 25 | | Vdc |
| Gate Reverse Current (VGS = -15 Vdc, V _{DS} = 0) (VGS = -15 Vdc, V _{DS} = 0, T _A = 100°C) | IGSS | _ | 1.0 1.0 | nAdc µAdc |
| Gate-Source Cutoff Voltage* (VDS = 15 Vdc, ID = 10 μAdc) | V _{GS(off)} * | 0.5 | 8.0 | Vdc |
| ON CHARACTERISTICS | | | | |
| Zero-Gate-Voltage Drain Current* (VDS = 15 Vdc, VGS = 0). | loss* | 1.5 | 24 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Forward Transfer Admittance (VDS = 15 Vdc, VGS = 0, f = 100 MHz) | lYfsl | 1600 | | μmhos |
| Forward Transadmittance* (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz) | Yfs* | 2000 | 7500 | μmhos |
| Input Admittance (VDS = 15 Vdc, VGS = 0, f = 100 MHz) | Re(y _{is}) | | 800 | μmhos |
| Output Admittance (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz) | lyosl | _ | 75 | μmhos |
| Output Conductance (Vps = 15 Vdc, Vgs = 0, f = 100 MHz) | Re(yos) | | 200 | μmhos |
| Input Capacitance (VDS = 15 Vdc, VGS = 0, f = 1.0 MHz) | Ciss | _ | 6.5 | ρF |
| Reverse Transfer Capacitance (VDS = 15 Vdc, VGS = 0, f = 1.0 MHz) | C _{rss} | | 2.5 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | |
| Noise Figure (VDS = 15 Vdc, VGS = 0, RG = 1.0 Megohm, f = 1.0 kHz) (VDS = 15 Vdc, VGS = 0, RG = 1.0 k ohm, f = 100 MHz) | NF | = | 2.5 3.0 | dB |

[•]To characterize these devices to narrower limits, regarding IDSS, VGS(off) and yfs, the entire production lot is tested and divided into color-coded groups, with each color dot representing a relatively small range compared with the total min-max limit of the whole distribution. The color codes and their associated limits are given in the following table.

When packaged for shipment, the colors are randomly selected and no specific color distribution is implied or guaranteed.

| Color | lps | VGS(off) | Yfs |
|--------|-----------------------------|--------------------------|--------------------|
| Orange | 1.5 mAdc, Min, 3.0 mAdc Max | 0.5 Vdc Min, 5.0 Vdc Max | 2000 to 6500 μmhos |
| Yellow | 2.5 mAdc Min, 5.0 mAdc Max | 0.5 Vdc Min, 5.0 Vdc Max | 2000 to 6500 μmhos |
| Green | 4.0 mAdc Min, 8.0 mAdc Max | 1.0 Vdc Min, 7.0 Vdc Max | 2500 to 7000 μmhos |
| Blue | 7.0 mAdc Min, 14 mAdc Max | 1.0 Vdc Min, 7.0 Vdc Max | 2500 to 7000 μmhos |
| Violet | 12 mAdc Min, 24 mAdc Max | 2.0 Vdc Min, 8.0 Vdc Max | 3000 to 7500 μmhos |

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET GENERAL PURPOSE

N-CHANNEL - DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|-------------|
| Drain-Source Voltage | VDS | 20 | Vdc |
| Drain-Gate Voltage | VDG | 20 | Vdc |
| Gate-Source Voltage | VGS | -20 | Vdc |
| Gate Current | IG | 10 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 310 2.0 | mW mW/°C |
| Junction Temperature Range | TJ | 125 | °C |
| Storage Channel Temperature Range | T _{sto} | -65 to +135 | •℃ |

Refer to 2N4220 for graphs.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|------------------|------|--------------|----------|----------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (IG = -10 µAdc, VDS = 0) | V(BR)GSS | -20 | | <u> </u> | Vdc |
| Gate Reverse Current (VGS = -10 Vdc, VDS = 0) | lgss l | - | 0.1 | 100 | nAdc |
| Gate Source Cutoff Voltage (VDS = 10 Vdc, I _D = 1.0 μAdc) | VGS(off) | -0.5 | | -10 | Vdc |
| ON CHARACTERISTICS | | | | · | <u> </u> |
| Zero-Gate-Voltage Drain Current(1) (VDS = 10 Vdc, VGS = 0) | IDSS | 0.5 | _ | 20 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | - | <u> </u> | <u> </u> |
| Forward Transfer Admittance(1) (VDS = 10 Vdc, VGS = 0, f = 1.0 kHz) | lyfsl | 500 | _ | _ | μmhos |
| Output Admittance(1) (VDS = 10 Vdc, VGS = 0, f = 1.0 kHz) | Yos | | 20 | _ | μmhos |
| Input Capacitance (VDS = 10 Vdc, VGS = 0, f = 1.0 MHz) | C _{iss} | | 4.5 | _ | рF |
| Reverse Transfer Capacitance (VDS = 10 Vdc, VGS = 0, f = 1.0 MHz) | C _{rss} | _ | 1.5 | | pF |

⁽¹⁾ Pulse Test: Pulse Width ≤ 630 ms; Duty Cycle ≤ 10%.

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET VHF AMPLIFIER

N-CHANNEL -- DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|--------------------|-------------|------------|
| Drain-Source Voltage | V _{DS} 25 | | Vdc |
| Drain-Gate Voltage | V _{DG} | 25 | Vdc |
| Gate-Source Voltage | VGS | - 25 | Vdc |
| Gate Current | IG | 10 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 200 2.0 | mW mW/℃ |
| Junction Temperature Range | TJ | 125 | ပ္ |
| Storage Channel Temperature Range | T _{stq} | -65 to +150 | င့ |

Refer to 2N4416 for graphs.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|------------------|-------------|-------|-----------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (I _G = -10 μAdc, V _{DS} = 0) | V(BR)GSS | - 25 | | - | Vdc |
| Gate Reverse Current (VGS = -10 Vdc, VDS = 0) | IGSS | _ | _ | 100 | nAdc |
| Gate Source Cutoff Voltage (Vps = 10 Vdc, lp = 1.0 µAdc) | VGS(off) | -0.5 | _ | -10 | Vdc |
| ON CHARACTERISTICS | | <u>,</u> | | | , |
| Zero-Gate-Voltage Drain Current(1) (VDS = 10 Vdc, VGS = 0) | IDSS | 1.0 | _ | 25 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transfer Admittance (VDS = 10 Vdc, VGS = 0, f = 1.0 kHz)(1) (VDS = 10 Vdc, VGS = 0, f = 100 MHz) | lyfsl | 1000 800 | _ | 7500 — | μmhos |
| Input Capacitance (VDS = 10 Vdc, VGS = 0, f = 1.0 MHz) | C _{iss} | _ | 8.0 | _ | pF |
| Reverse Transfer Capacitance (VDS = 10 Vdc, VGS = 0, f = 1.0 MHz) | C _{rss} | _ | 3.0 | - | ρF |

⁽¹⁾ Pulse Test: Pulse Width ≤ 630 ms; Duty Cycle ≤ 10%.

MPF130,131,132 MFE130,131,132

MPF130 SERIES CASE 317-01, STYLE 1

MFE130 SERIES CASE 20-03, STYLE 9 TO-72 (TO-206AF)

> DUAL-GATE MOSFET VHF AMPLIFIER

N-CHANNEL - DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | | Unit |
|---|--|------------------|------------------|-------------|
| Drain-Source Voltage | VDS | 2 | Vdc | |
| Drain Current | ID | 30 | | mAdc |
| | | MPF130 Series | MFE130 Series | |
| Total Device Dissipation @ TA = 25°C (Package Limitation) | PD | 300 | 300 | mW mW/°C |
| Derate above 25°C | 1 | 2.4 | 1.71 | |
| Operating and Storage Channel Temperature Range | T _{channel} , T _{stg} | - 65 to + 150 | -65 to +175 | °C |

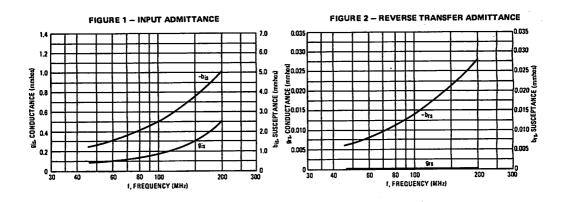
| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|------------------------|------|-------------------|-------------------|-------|
| OFF CHARACTERISTICS | | | | | |
| Drain-Source Breakdown Voltage (ID = 10 µAdc, VS = 0, VG1 = -4.0 V, VG2 = +4.0 V) | V(BR)DSX | 25 | _ | _ | Vdc |
| Gate 1-Source Breakdown Voltage (IG1 = ±10 µAdc, VG2S = 0) | V _(BR) G1SO | ±7.0 | | ±20 | Vdc |
| Gate 2-Source Breakdown Voltage (IG2 = ±10 µAdc, VG2S = 0) | V(BR)G2SO | ±7.0 | | ± 20 | Vdc |
| Gate 1 Leakage Current (VG1S = ±6.0 Vdc, VG2S = 0, VDS = 0) | Giss | _ | _ | 20 | nAdc |
| Gate 2 Leakage Current (VG2S = ±6.0 Vdc, VG1S = 0, VDS = 0) | lG2SS | _ | _ | 20 | nAdc |
| Gate 1 to Source Cutoff Voltage (V _{DS} = 15 Vdc, V _{G2S} = 4.0 Vdc, l _D = 200 μAdc) | VG1S(off) | * | - | -4.0 | Vdc |
| Gate 2 to Source Cutoff Voltage (VDS = 15 Vdc, V _{G1S} = 0, t _D = 200 μAdc) | V _{G2S(off)} | - | _ | -4.0 | Vdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current (VDS = 15 Vdc, VG1S = 0, VG2S = 4.0 Vdc) | IDSS | 3.0 | 10 | 30 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transfer Admittance (Gate 1 connected to Drain) (VDS = 15 Vdc, VG2S = 4.0 Vdc, ID = 10 mAdc, f = 1.0 kHz) | İVfsİ | 8000 | _ | 20000 | μmhos |
| Input Capacitance (VDS = 15 Vdc VG2S = 4.0 Vdc, ID = IDSS, f = 1.0 MHz) | Ciss | _ | 4.5 | 7.0 | pF |
| Reverse Transfer Capacitance (VDS = 15 Vdc, VG2S = 4.0 Vdc, ID = 6.0 mAdc, f = 1.0 MHz) | C _{rss} | _ | 0.023 | 0.05 | pF |
| Output Capacitance (VDS = 15 Vdc, VG2S = 4.0 Vdc, ID = IDSS, f = 1.0 MHz) | Coss | | 2.5 | 4.0 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | | |
| Noise Figure (Figure 7) (Vps = 15 Vdc, Vg2S = 4.0 Vdc, Ip = 6.0 mAdc, Zs is optimized for NF) (f = 105 MHz) MPF/MFE130 | NF | - | | | dB |
| (f = 105 MHz) MPF/MFE130 (f = 60 MHz) MPF/MFE131 (f = 100 MHz) MPF/MFE131 | | = | 2.9 2.5 3.0 | 5.0 5.0 5.0 | |

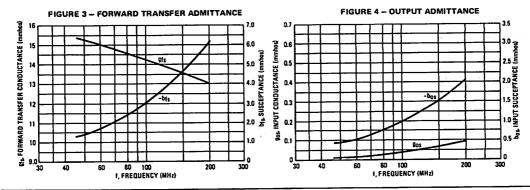
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|--------------|-----------------|-----|------|-----|------|
| Common Source Power Gain (Figure 7) (VDS = 15 Vdc, VG2S = 4.0 Vdc, ID = 6.0 mAdc, ZS is optimized for NF) | | G _{ps} | | | | dB |
| (f = 105 MHz) | MPF/MFE130 | | 17 | 23 | ! — | |
| (f = 60 MHz) | MPF/MFE131 | | 20 | 27 | 1 — | |
| (f = 200 MHz) | MPF/MFE131 | L | 17 | 20 | | |
| Level of Unwanted Signal for 1.0% Cross Modulation (VDS = 15 Vdc, VG2S = 4.0 Vdc, ID = 6.0 mAdc) | | - | _ | 100 | _ | mV |
| Common-Source Conversion Power Gain (Gate 1 Injectio (VDS = 15 Vdc, VG2S = 4.0 Vdc, Local Oscillator Voltage = 925 mVrms) (Signal Frequency = 60 MHz, Local Oscillator | n, Figure 8) | G _c | | | | dB |
| Frequency = 104 MHz) | MPF/MFE132 | 1 | 15 | 16.5 | - | |
| (Signal Frequency = 200 MHz, Local Oscillator Frequency = 244 MHz) | MPF/MFE132 | | 12 | 14 | _ | |

COMMON-SOURCE ADMITTANCE PARAMETERS

(VDS = 15 Vdc, VG2S = 4.0 Vdc, ID = 6.0 mAdc)





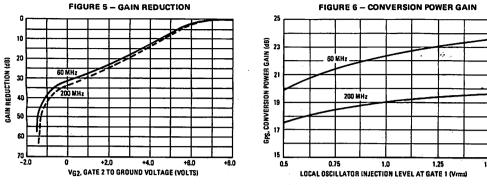


FIGURE 7 - 60, 105 AND 200 MHz POWER GAIN AND NOISE FIGURE TEST CIRCUIT

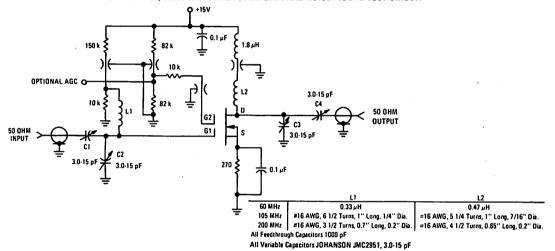
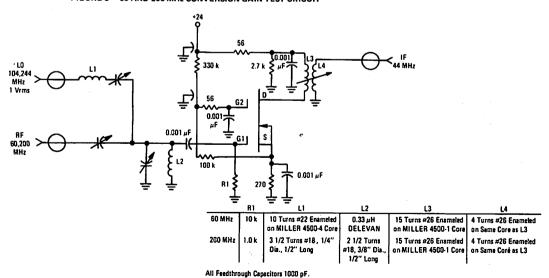


FIGURE 8 - 60 AND 200 MHz CONVERSION GAIN TEST CIRCUIT



MPF130,131,132, MFE130,131,132

All Variable Capacitors JOHANSON JMC2951, 3.0-15 pF.

MPF201 MPF202 MPF203

CASE 317-01, STYLE 1

DUAL-GATE MOSFET VHF AMPLIFIER

N-CHANNEL - DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|--------------------------------------|--------------|---------------|
| Drain-Source Voltage | VDS | 25 | Vdc |
| Drain-Gate Voltage | V _{DG1} V _{DG2} | 30 30 | Vdc |
| Drain Current | ĺD | 50 | mAdc |
| Gate Current | IG1 IG2 | ± 10 ± 10 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 2.4 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 8.0 | Watt mW/°C |
| Lead Temperature | TL | 260 | ပ္ |
| Junction Temperature Range | TJ | -65 to +150 | ç |
| Storage Channel Temperature Range | T _{stg} | -65 to +150 | °C |

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|-------------------|------------|--------------|----------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Drain-Source Breakdown Voltage (ID = 10 μAdc, VS = 0, VG1S = VG2S = -5.0 Vdc) | V(BR)DSX | 25 | _ | _ | Vdc |
| Gate 1-Source Breakdown Voltage(1) (IG1 = ±10 mAdc, VG2S = VDS = 0) | V(BR)G1SO | ± 6.0 | ± 12 | ±30 | Vdc |
| Gate 2-Source Breakdown Voltage(1) (IG2 = ±10 mAdc, VG1S = VDS = 0) | V(BR)G2SO | ± 6.0 | ±12 | ±30 | Vdc |
| Gate 1 Leakage Current {VG1S = ±5.0 Vdc, VG2S = VDS = 0} {VG1S = -5.0 Vdc, VG2S = VDS = 0, TA = 150°C} | ^I G1SS | - | ±0.040 | ± 100 - 100 | nAdc μAdc |
| Gate 2 Leakage Current {VG2S = ±5.0 Vdc, VG1S = VDS = 0} {VG2S = -5.0 Vdc, VG1S = VDS = 0, TA = 150°C} | IG2SS | | ±0.050 — | ± 100 - 100 | nAdc μAdc |
| Gate 1 to Source Cutoff Voltage (V _{DS} = 15 Vdc, V _{G2S} = 4.0 Vdc, I _D = 20 μAdc) | VG1S(off) | - 0.5 | - 1.5 | -5.0 | Vdc |
| Gate 2 to Source Cutoff Voltage (V _{DS} = 15 Vdc, V _{G1S} = 0, I _D = 20 μAdc) | VG2S(off) | -0.2 | -1.4 | -5.0 | Vdc |
| ON CHARACTERISTICS | . | | | | , |
| Zero-Gate-Voltage Drain Current(2) (VDS = 15 Vdc, VG1S = VG2S = 4.0 Vdc) MPF201, MPF202 MPF203 | IDSS | 6.0 3.0 | 13 11 | 30 15 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transfer Admittance(3) (VDS = 15 Vdc, VG2S = 4.0 Vdc, VG1S = 0, f = 1.0 kHz) MPF201, MPF202 MPF203 | Y _{fs} | 8.0 7.0 | 12.8 12.5 | 20 15 | mmhos |
| Input Capacitance (VDS = 15 Vdc, VG2S = 4.0 Vdc, ID = IDSS, f = 1.0 MHz) | C _{iss} | - | 3.3 | _ | pF |
| Reverse Transfer Capacitance (VDS = 15 Vdc, VG2S = 4.0 Vdc, ID = 10 mAdc, f = 1.0 MHz) | C _{rss} | 0.005 | 0.014 | 0.05 | pF |
| Output Capacitance (VDS = 15 Vdc, VG2S = 4.0 Vdc, ID = IDSS, f = 1.0 MHz) | Coss | _ | 1.7 | _ | pF |
| FUNCTIONAL CHARACTERISTICS | | | | | |
| Noise Figure (VDD = 18 Vdc, VGG = 7.0 Vdc, f = 200 MHz) (Figure 1) (VDD = 18 Vdc, VGG = 6.0 Vdc, f = 45 MHz) (Figure 3) MPF203 | NF | | 1.8 5.3 | 5.0 6.0 | dB |

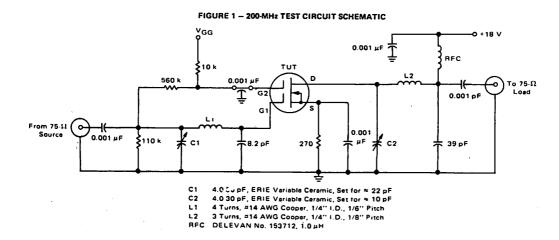
MPF201, MPF202, MPF203

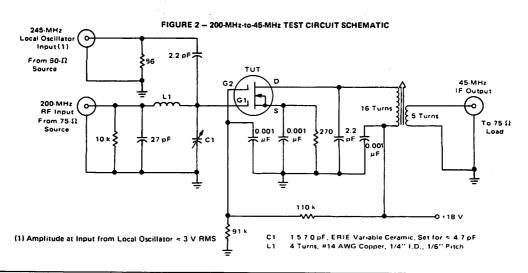
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|--------|--------------------|-----|-------|-------|------|
| Common Source Power Gain | | Gps | | | | dB |
| (VDD = 18 Vdc, VGG = 7.0 Vdc, f = 200 MHz) (Figure 1) | MPF201 | , , | 15 | 20 | 25 | |
| (V _{DD} = 18 Vdc, V _{GG} = 6.0 Vdc, f = 45 MHz) (Figure 3) | MPF203 | | 20 | 25 | 30 | |
| $(V_{DD} = 18 \text{ Vdc, f }_{LO} = 245 \text{ MHz, f}_{RF} = 200 \text{ MHz}) \text{ (Figure 2)}$ | MPF202 | G _c (5) | 15 | 19 | 25 | |
| Bandwidth | | BW | | | | MHz |
| (VDD = 18 Vdc, VGG = 7.0 Vdc, f = 200 MHz) (Figure 1) | MPF201 | | 5.0 | _ | 9.0 | |
| (VDD = 18 Vdc, fLO = 245 MHz, fRF = 200 MHz) (Figure 2) | MPF202 | | 4.5 | _ | 7.5 | |
| (V _{DD} = 18 Vdc, V _{GG} = 6.0 Vdc, f = 45 MHz) (Figure 3) | MPF203 | | 3.0 | - | 6.0 | |
| Gain Control Gate-Supply Voltage(4) | | VGG(GC) | | | | Vdc |
| $(V_{DD} = 18 \text{ Vdc}, \Delta G_{DS} = -30 \text{ dB}, f = 200 \text{ MHz}) \text{ (Figure 1)}$ | MPF201 | 22(00) | 0 | - 1.0 | - 3.0 | |
| $(V_{DD} = 18 \text{ Vdc}, \Delta G_{DS} = -30 \text{ dB}, f = 45 \text{ MHz}) \text{ (Figure 3)}$ | MPF203 | | 0 | -0.6 | - 3.0 | |

⁽¹⁾ All gate breakdown voltages are measured while the device is conducting rated gate current. This ensures that the gate-voltage limiting network is functioning properly.

(5) Power Gain Conversion



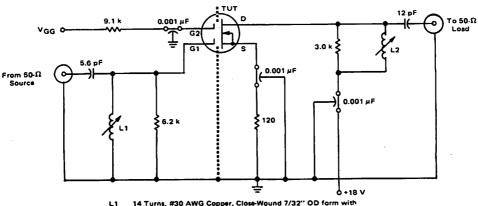


⁽²⁾ Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2.0%.

⁽³⁾ This parameter must be measured with bias voltages applied for less than 5 seconds to avoid overheating.

⁽⁴⁾ ΔG_{ps} is defined as the change in G_{ps} from the value at $V_{GG}=7.0$ volts (MPF201) and $V_{GG}=6.0$ volts (MPF203).

FIGURE 3 - 45-MHz TEST CIRCUIT SCHEMATIC



- 14 Turns, #30 AWG Copper, Close-Wound 7/32" OD form with ARNOLD ENGINEERING "J" Tuning Core
- 10 Turns, #30 AWG Copper, Close-Wound 7/32" OD form with ARNOLD ENGINEERING "J" Tuning Core L2

TYPICAL CHARACTERISTICS

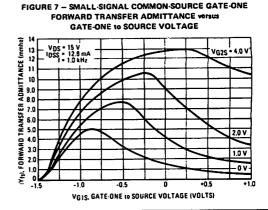
FIGURE 4 - DRAIN CURRENT versus DRAIN to SOURCE VOLTAGE VG25 - 4.0 V IDSS = 12.8 mA 26 24 VG1S = +1.0 V , 22 20 (D. ORAIN CURRENT (mA) +0.5 V 18 16 14 12 10 8.0 -0.5 -1.0 Ý

VDS. DRAIN-TO-SOURCE VOLTAGE (VOLTS)

FIGURE 6 - SMALL-SIGNAL COMMON-SOURCE GATE-ONE

FIGURE 5 - DRAIN CURRENT versus GATE-ONE to SOURCE VOLTAGE 26 VDS = 15 V IDSS = 12.8 mA 24 VG2S 22 ID, DRAIN CURRENT (mA) 20 18 16 14 12 10 6.0 4.0 -1.0 V 2.0 10 VGIS. GATE-ONE-TO-SOURCE VOLTAGE (VOLTS)

FORWARD TRANSFER ADMITTANCE versus DRAIN CURRENT VG2S = +4.0 V VOS = 15 V IDSS = 12.8 mA 13 12 f = 1.0 kHz 0 V VGIS -1.0 V VG15 * 1.0 V ID, DRAIN CURRENT (mA)



SMALL-SIGNAL DEVICES

MPF201, MPF202, MPF203

FIGURE 8 – SMALL-SIGNAL COMMON-SOURCE GATE-ONE FORWARD TRANSFER ADMITTANCE versus GATE-TWO to SOURCE VOLTAGE

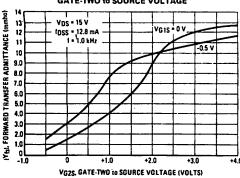


FIGURE 9 – SMALL-SIGNAL COMMON-SOURCE GATE-ONE INPUT AND OUTPUT CAPACITANCE versus

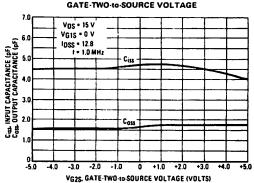


FIGURE 10 – COMMON-SOURCE POWER GAIN AND SPOT NOISE FIGURE WITE DRAIN CURRENT

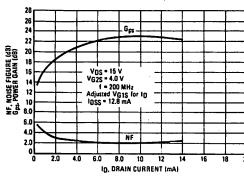


FIGURE 11 — COMMON-SOURCE POWER GAIN AND SPOT NOISE FIGURE versus GAIN CONTROL

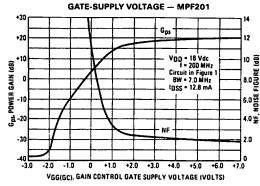


FIGURE 12 — SMALL-SIGNAL COMMON SOURCE
INSERTION POWER GAIN VEITURE GAIN CONTROL

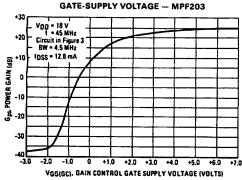
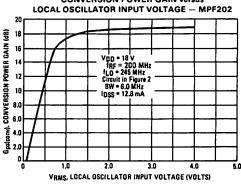


FIGURE 13 — SMALL-SIGNAL COMMON-SOURCE
CONVERSION POWER GAIN versus



MPF201, MPF202, MPF203

FIGURE 14 — SMALL-SIGNAL GATE ONE FORWARD TRANSFER ADMITTANCE versus FREQUENCY

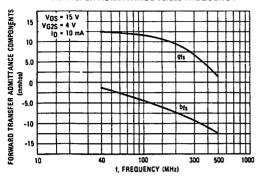


FIGURE 15 — SMALL-SIGNAL GATE ONE INPUT
ADMITTANCE Versus FREQUENCY

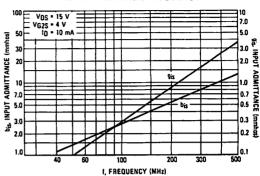


FIGURE 16 — SMALL-SIGNAL GATE ONE OUTPUT ADMITTANCE versus FREQUENCY

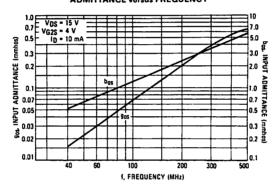
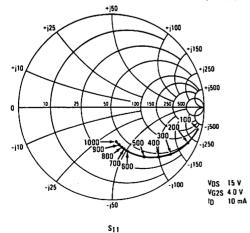
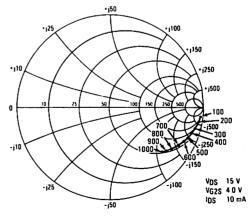


FIGURE 17 -- S PARAMETERS PLOTTED ON 50 OHM SMITH CHART





S22

SMALL-SIGNAL DEVICES

MAXIMUM RATINGS

| MAXIMOM NATINGS | | | | |
|---|--------------------------------------|------------------|----------|---------------|
| Rating | Symbol | MPF211 MPF212 | MPF213 | Unit |
| Drain-Source Voltage | V _{DS} | 27 | 35 | Vdc |
| Drain-Gate Voltage | V _{DG1} V _{DG2} | 35 40 35 40 | | Vdc |
| Drain Current — Continuous | ΙD | 5 | mAdc | |
| Gate Current | IG1 IG2 | ± 10 ± 10 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 1.71 | | mW. mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 1.2 8.0 | | Watt mW/°C |
| Lead Temperature, 1/16" From Seated Surface for 10 Seconds | TL | 260 | | °C |
| Junction Temperature Range | Tj | -65 to +150 | | °C |
| Storage Channel Temperature Range | T _{sta} | - 65 to | + 150 °C | |

MPF211 MPF212 MPF213

CASE 317-01, STYLE 1

DUAL-GATE MOSFET VHF AMPLIFIER

N-CHANNEL — DEPLETION

| Characteristic | | Symbol | Min | Max | Unit |
|---|----------------------|------------------------|----------------|----------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Drain-Source Breakdown Voltage (VG1S = VG2S = -4.0 Vdc, ID = $10 \mu Adc$) | MPF211,212 MPF213 | V(BR)DSX | 25 30 | _ | Vdc |
| Instantaneous Drain-Source Breakdown Voltage(1) (VG1S = VG2S = -4.0 Vdc, l _D = 10 μAdc) | MPF211,212 MPF213 | V(BR)DSX | 27 35 | = | Vdc |
| Gate 1-Source Breakdown Voltage(2) (VG2S = VDS = 0, IG1 = ±10 mAdc) | | V(BR)G1SO | ± 6.0 | _ | Vdc |
| Gate 2-Source Breakdown Voltage(2) (VG1S = VDS = 0, IG2 = ±10 mAdc) | | V(BR)G2SO | ± 6.0 | - | Vdc |
| Gate 1 Leakage Current (VG1S = ±5.0 Vdc, VG2S = VDS = 0) (VG1S = -5.0 Vdc, VG2S = VDS = 0, TA = 150°C) | | IG1SS | ± 0.04(Typ) | ± 100 - 100 | nAdc μAdc |
| Gate 2 Leakage Current (VG2S = ±5.0 Vdc, VG1S = VDS = 0) (VG2S = -5.0 Vdc, VG1S = VDS = 0, TA = 150°C) | | I _{G2SS} | ± 0.04(Typ) | ± 100 100 | nAdc μAdc |
| Gate 1 to Source Cutoff Voltage (VDS = 15 Vdc, VG2S = 4.0 Vdc, ID = 2.0 μAdc) | MPF211,213 MPF212 | VG1S(off) | - 0.5 - 0.5 | - 5.5 - 4.0 | Vdc |
| Gate 2 to Source Cutoff Voltage (VDS = 15 Vdc, V_{G1S} = 0, I_D = 20 μ Adc) | MPF211 MPF212,213 | V _{G2} S(off) | -0.2 -0.2 | - 2.5 - 4.0 | Vdc |
| ON CHARACTERISTICS | | • | | | • |
| Zero-Gate-Voltage Drain Current(3) (Vps = 15 Vdc, Vg1s = 0, Vg2s = 4.0 Vdc) | | IDSS | 6.0 | 4.0 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transfer Admittance(4) (VDS = 15 Vdc, V_{G2S} = 4.0 Vdc, V_{G1S} = 0, f = 1.0 kHz) | MPF211,212 MPF213 | Y _{fs} | 17 15 | 40 35 | mmhos |
| Reverse Transfer Capacitance $\{V_{DS}=15\ V_{dc},\ V_{G2S}=4.0\ V_{dc},\ I_D=10\ mAdc,\ f=1.0\ MHz$ | ·lz) | C _{rss} | 0.005 | 0.05 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | | |
| Noise Figure $(V_{DD}=18\ Vdc,\ V_{GG}=7.0\ Vdc,\ f=200\ MHz)\ (Figure\ 1)$ $(V_{DD}=24\ Vdc,\ V_{GG}=6.0\ Vdc,\ f=45\ MHz)\ (Figure\ 2)$ | MPF211 MPF211,213 | NF | _ | 4.0 4.5 | dB |

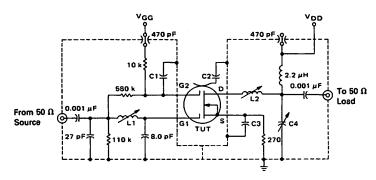
MPF211, MPF212, MPF213

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|---|------------|--------------------|-----|-------|------|
| Common Source Power Gain | | G _{DS} | | | dВ |
| (V _{DD} = 18 Vdc, V _{GG} = 7.0 Vdc, f = 200 MHz) (Figure 1) | MPF211 | | 24 | 35 | |
| (VDD = 24 Vdc, VGG = 6.0 Vdc, f = 45 MHz) (Figure 2) | MPF211 | | 29 | 37 | |
| (VDD = 24 Vdc, VGG = 6.0 Vdc, f = 45 MHz) (Figure 2) | MPF213 | 1 | 27 | 35 | |
| (VDD = 18 Vdc, fLO = 245 MHz, fRE = 200 MHz) (Figure 3) | MPF212 | G _C (6) | 21 | 38 | |
| Bandwidth | | BW | | | MHz |
| (VDD = 18 Vdc, VGG = 7.0 Vdc, f = 200 MHz) (Figure 1) | MPF211 | | 5.0 | 12 | |
| (VDD = 18 Vdc, fl O = 245 MHz, fge = 200 MHz) (Figure 3) | MPF212 | | 4.0 | 7.0 | |
| (VDD = 24 Vdc, VGG = 6.0 Vdc, f = 45 MHz) (Figure 2) | MPF211,213 | | 3.5 | 6.0 | |
| Gain Control Gate-Supply Voltage(5) | | VGG(GC) | | [| Vdc |
| $(V_{DD} = 18 \text{ Vdc}, \Delta G_{DS} = -30 \text{ dB}, f = 200 \text{ MHz}) \text{ (Figure 1)}$ | MPF211 | 35,557 | _ | -2.0 | |
| $(V_{DD} = 24 \text{ Vdc}, \Delta G_{DS} = -30 \text{ dB}, f = 45 \text{ MHz}) \text{ (Figure 2)}$ | MPF211,213 | | | ± 1.0 | |

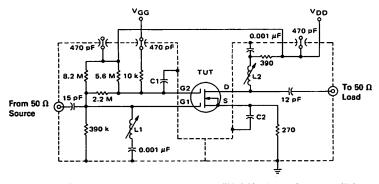
- (1) Measured after five seconds of applied voltage.
- (2) All gate breakdown voltages are measured while the device is conducting rated gate current. This ensures that the gate voltage limiting network is functioning properly.
- (3) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2.0%.
- (4) This parameter must be measured with bias voltages applied for less than 5 seconds to avoid overheating. The signal is applied to Gate 1 with Gate 2 at ac ground.
- (5) ΔG_{ps} is defined as the change in G_{ps} from the value at $V_{GG} = 7.0$ Volts (MPF211) and $V_{GG} = 6.0$ Volts (MPF213).
- (6) Power Gain Conversion. Amplitude at input from local oscillator is adjusted for maximum Gc.

FIGURE 1 — 200 MHz POWER GAIN, GAIN CONTROL VOLTAGE, AND NOISE FIGURE TEST CIRCUIT



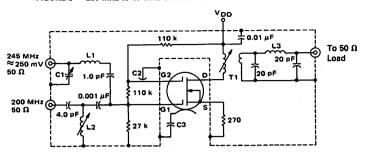
- C1, C2 & C3: Leadless disc ceramic, 0.001 μ F C4: Arco 462, 5-80 pF, or equivalent
- L1: 3 Turns #18, 3/16" diameter aluminum slug L2: 8 Turns #20, 3/16" diameter aluminum slug

FIGURE 2 — 45-MHz POWER GAIN AND NOISE FIGURE TEST CIRCUIT



- C1: Leadless disc ceramic, 0.001 μF
- L1: 8 Turns #28, 5/32" diameter form, type "J" slug
- C2: Leadless disc ceramic, 0.01 µF
- L2: 9 Turns #28, 5/32" diameter form, type "J" slug

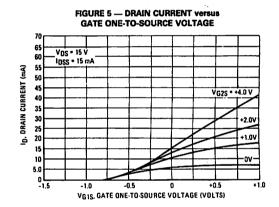
FIGURE 3 - 200-MHz-to-45-MHz CIRCUIT FOR CONVERSION POWER GAIN



- L1: 7 Turns #34, 1/4" diameter aluminum slug
- L2: 5-1/2 Turns #20, 1/4" diameter eluminum slug L3: 7 Turns #24, 1/4" diameter elr core
- C1: Arco type 462, 5-80 pF
- C2: 0.001 µF leadless disc C3: 0.01 µF leadless disc
- T1: Pri: 25 Turns #30, close wound on 1/4"
 - diameter form, type "J" slug
 - Sec: 4 Turns #30, centered over primary

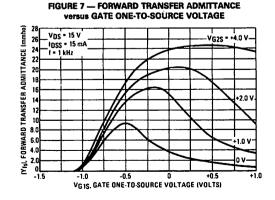
TYPICAL CHARACTERISTICS

FIGURE 4 - DRAIN CURRENT versus DRAIN-TO-SOURCE VOLTAGE VG2S = +4.0 V 65 VG15 = 2.0 V IDSS = 15 mA 55 ID. DRAIN CURRENT (mA) 50 45 40 35 30 ·O. 25 20 οv 15 10 -0.5 V 0 6.0 80 10 12 VDS, DRAIN-TO-SOURCE VOLTAGE (VOLTS)



SMALL-SIGNAL COMMON-SOURCE PARAMETER — GATE ONE

FIGURE 6 - FORWARD TRANSFER ADMITTANCE versus GATE TWO-TO-SOURCE VOLTAGE Yes. FORWARD TRANSFER ADMITTANCE (mmhos) _VDS = 15 V .IDSS = 15 mA 26 VG15 - 0 V 24 1 = 1 kHz 22 20 18 VG1S = 0.5 V 16 14 12 10 8.0 6.0 VG2S, GATE TWO-TO-SOURCE VOLTAGE (VOLTS)



SMALL-SIGNAL DEVICES

MOTOROLA SEMICONDUCTORS

FIGURE 8 — FORWARD TRANSFER ADMITTANCE versus DRAIN CURRENT

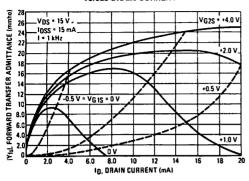


FIGURE 9 — INPUT AND OUTPUT CAPACITANCE versus GATE TWO-TO-SOURCE VOLTAGE

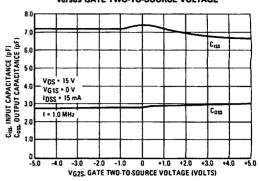


FIGURE 10 — SMALL-SIGNAL GATE ONE INPUT ADMITTANCE versus FREQUENCY

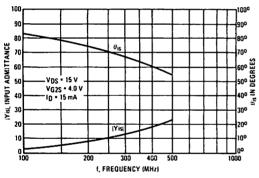


FIGURE 11 — SMALL-SIGNAL FORWARD TRANSFER ADMITTANCE versus FREQUENCY

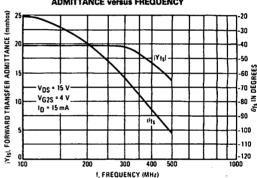


FIGURE 12 — SMALL-SIGNAL GATE ONE REVERSE TRANSFERS
ADMITTANCE Versus FREQUENCY

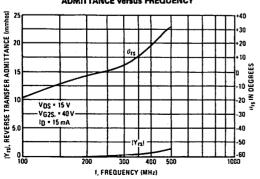
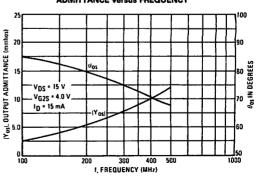


FIGURE 13 — SMALL-SIGNAL GATE ONE OUTPUT ADMITTANCE versus FREQUENCY



MPF211, MPF212, MPF213

FIGURE 14 — RELATIVE SMALL-SIGNAL POWER GAIN versus
GAIN CONTROL GATE SUPPLY VOLTAGE
MPF211

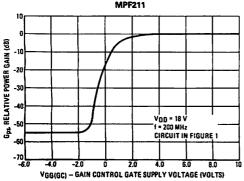


FIGURE 15 — COMMON SOURCE SPOT NOISE FIGURE
Versus
GAIN CONTROL GATE SUPPLY VOLTAGE

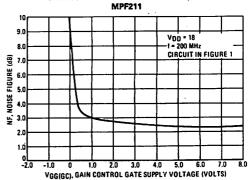


FIGURE 16 — SMALL-SIGNAL COMMON-SOURCE INSERTION POWER GAIN VERSUS GAIN CONTROL GATE SUPPLY VOLTAGE

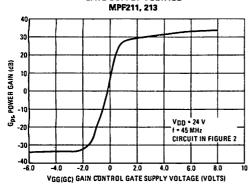


FIGURE 17 — OPTIMUM SPOT NOISE FIGURE
Versus FREQUENCY

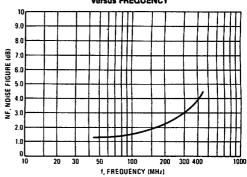
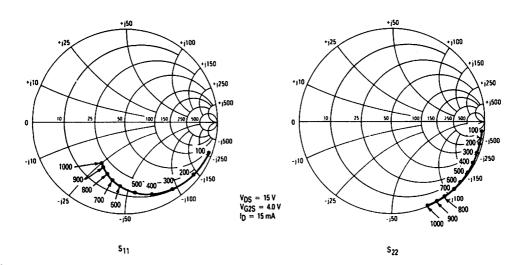


FIGURE 18 - INPUT/OUTPUT IMPEDANCE



MPF230 MPF231 MPF232

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET LOW NOISE AMPLIFIER

N-CHANNEL - DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|-------------|
| Drain-Source Voltage | VDS | -40 | Vdc |
| Drain-Gate Voltage | VDG | 40 | Vdc |
| Gate-Source Voltage | VGS | 40 | Vdc |
| Gate Current | l _G | 50 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 310 2.82 | mW mW/°C |
| Storage Temperature Range | T _{stq} | -65 to +150 | °C |

Refer to 2N4220 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|--|----------------------------|-----------------------|-------------------------|----------------------|--------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (I _G = -1.0 μA) | | V _(BR) GSS | -40 | _ | Vdc |
| Gate Reverse Current (VGS = -30 V) | | l _{GSS} | _ | - 250 | pA |
| Gate Source Cutoff Voltage (VDS = 20 V, ID = 1.0 μ A) | MPF230 MPF231 MPF232 | VGS(off) | - 1.0 - 2.0 - 3.0 | -3.0 -5.0 -6.0 | Vdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current (V _{DS} = 20 V) | MPF230 MPF231 MPF232 | DSS* | 0.7 2.0 5.0 | 3.0 6.0 10.0 | mA |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transfer Admittance (VDS = 20 V, f = 1.0 kHz) | MPF230 MPF231 MPF232 | vfs * | 1000 1500 2500 | 3000 3000 4500 | μmhos |
| FUNCTIONAL CHARACTERISTICS | | | | | |
| Equivalent Short-Circuit Input Noise Voltage (Vps = 10 V, f = 10 Hz) | | ēn | | 30 | nV/√Hz |

^{*}Pulse Width ≤ 2.0 msec.

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

> JFET AMPLIFIER

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|----------------------|-------------|-------------|
| Drain-Source Voltage | VDS | ±30 | Vdc |
| Drain-Gate Voltage | VDG | 30 | Vdc |
| Reverse Gate-Source Voltage | VGSR | 30 | Vdc |
| Forward Gate Current | IG(f) | 10 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 2.73 | mW mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +150 | င |

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | · · · · · · · · · · · · · · · · · · · | Symbol | Min | Тур | Max | Unit |
|---|---------------------------------------|------------------|------------------|-------------|-----------------|-------------|
| OFF CHARACTERISTICS | | | | | | |
| Gate-Source Breakdown Voltage (I _G = 10 μAdc, V _{DS} = 0) | | V(BR)GSS | 25 | _ | - | Vdc |
| Gate Reverse Current (VGS = 15 Vdc, VDS = 0) | | IGSS | - | - | 5.0 | nAdc |
| Gate Source Cutoff Voltage (V _{DS} = 15 Vdc, I _D = 200 μAdc) | | VGS(off) | 0.5 | - | 7.5 | Vdc |
| ON CHARACTERISTICS | | | | | | |
| Zero-Gate-Voltage Drain Current (VDS = 15 Vdc, VGS = 0) | Red Green Violet | loss* | 3.0 6.0 11 | - - - | 7.0 13 18 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | • | |
| Forward Transfer Admittance (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz) | | lyfsl | 6.0 | _ | _ | mmhos |
| Input Capacitance (Vps = 15 Vdc, Ip = 10 mAdc, f = 1.0 MHz) | | C _{iss} | _ | 3.0 | _ | pF |
| Reverse Transfer Capacitance (V _{DS} = 15 Vdc, I _D = 10 mAdc, f = 1.0 MHz) | | C _{rss} | _ | 1.2 | _ | pF |
| Output Capacitance (V _{DS} = 15 Vdc, I _D = 10 mAdc, f = 1.0 kHz) | | Coss | _ | 2.0 | _ | pF |
| FUNCTIONAL CHARACTERISTICS | | | | | | |
| Noise Figure (V _{DS} = 15 Vdc, R _S = 50 Ohms) | 100 MHz 400 MHz | NF | _ | _ | 2.0 4.0 | dB |
| Common Source Power Gain (VDS = 15 Vdc, RS = 50 Ohms) | 100 MHz 400 MHz | G _{ps} | 20 12 | = | _ | dB |

^{*}To characterize these devices to narrower limits, the entire production lot is tested and divided into color-coded groups, with each color dot representing an IDSS range.

When packaged for shipment, the colors are randomly selected and no specific color distribution is implied or guaranteed.

CASE 317-01, STYLE 1

MOSFET
DUAL GATE
VHF AMPLIFIER TRANSISTOR

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|--------------------------------------|-------------|-------------|
| Drain-Source Voltage | V _{DS} | 25 | Vdc |
| Drain-Gate Voltage | V _{DG1} V _{DG2} | 30 30 | Vdc |
| Drain Current | ID | 30 | mAdc |
| Gate Current | IG1F IG2F | 10 10 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 1.71 | mW mW/°C |
| Operating Channel Temperature | T _{channel} | 150 | °C |
| Lead Temperature, 1/16" From Seated Surface for 10 Seconds | TL | 200 | °C |
| Storage Channel Temperature Range | T _{stg} | -65 to +150 | °C |

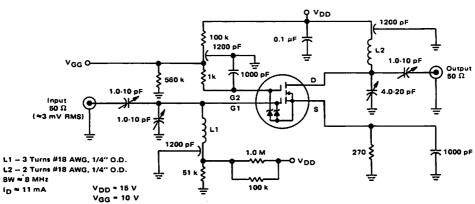
| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|--------------------------|--------------|-------------------|------------|-------|
| OFF CHARACTERISTICS | | | | | |
| Gate 1-Source Breakdown Voltage (VG2 = VDS = 0, IG1 = 10 μAdc) | V(BR)G1SO | 10 | 15 | _ | Vdc |
| Gate 2-Source Breakdown Voltage (VG1S = VDS = 0, IG2 = 10 μAdc) | V(BR)G2SO | 12 | 16 | _ | Vdc |
| Gate 1 Reverse Leakage Current (VG1S = 5.0 Vdc, VG2S = VDS = 0) | lG1SS | - | 30 | 100 | nAdc |
| Gate 2 Reverse Leakage Current (VG2S = 5.0 Vdc, VG1S = VDS = 0) | IG2SS | _ | 30 | 100 | nAdc |
| Drain-Source Breakdown Voltage (VG2 = 0, I _D = 10 µAdc) | V(BR)DS | 25 | 28 | | Vdc |
| ON CHARACTERSTICS | | | | | |
| Gate-Source Threshold Voltage (VG2S = 10 Vdc, I _D = 10 μAdc, V _{DS} = 15 V) (VG1S = 4.0 Vdc, I _D = 10 μAdc, V _{DS} = 15 V) | VG1S(TH) VG2S(TH) | 0.5 0.5 | 1.2 1.0 | 2.0 2.0 | Vdc |
| Gate-Source On Voltage (VDS = 15 Vdc, VG2S = 10 Vdc, ID = 10 mAdc) | VG1S(on) | 2.0 | 2.6 | 4.0 | Vdc |
| "On" Drain Current (VDS = 15 Vdc, VG2S = 10 Vdc, VG1S = 3.0 Vdc) | lD(on) | 5.0 | 15 | 20 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transfer Admittance(1) $(V_{DS} = 15 \text{ Vdc}, V_{G2S} = 10 \text{ Vdc}, I_D = 10 \text{ mAdc}, f = 1.0 \text{ kHz})$ $(V_{DS} = 15 \text{ Vdc}, V_{G2S} = 10 \text{ Vdc}, I_D = 10 \text{ mAdc}, f = 200 \text{ MHz})$ | Y _{fs} Yfs | 10 — | 12 10.57-j6.86 | 20 — | mmhos |
| input Admittance(1) (VDS = 15 Vdc, VG2S = 10 Vdc, I_D = 10 mAdc, f = 200 MHz) | Yis | | 0.524 + j4.27 | _ | mmhos |
| Reverse Transfer Admittance(1) ($V_{DS} = 15 \text{ Vdc}, V_{G2S} = 10 \text{ Vdc}, I_{D} = 10 \text{ mAdc}, f = 200 \text{ MHz}$) | Yrs | _ | -1.7-j9.8 | _ | μmhos |
| Output Admittance(1) (VDS = 15 Vdc, VG2S = 10 Vdc, ID = 10 mAdc, f = 200 MHz) | Yos | _ | 0.126+j1.79 | _ | mmhos |
| Input Capacitance (VDS = 15 Vdc, VG2S = 10 Vdc, $VG1 = 2.5 Vdc$, $f = 1.0 MHz$) | Ciss | _ | 3.3 | 4.0 | pF |
| Reverse Transfer Capacitance (VDS = 15 Vdc, VG2S = 10 Vdc, VG1 = 2.5 Vdc, f = 1.0 MHz) | C _{rss} | | 0.015 | 0.03 | pF |
| Output Capacitance (V _{DS} = 15 Vdc, V _{G2S} = 10 Vdc, V _{G1} = 2.5 Vdc, f = 1.0 MHz) | Coss | _ | 1.1 | 2.5 | pF |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

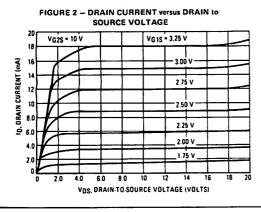
| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|-----------------|-----|-----|-----|------|
| FUNCTIONAL CHARACTERISTICS | | | | | |
| Noise Figure (Figures 1 and 9) (V _{DS} = 15 Vdc, V _{GG} = 10 V, f = 200 MHz) | NF | _ | 1.7 | 3.5 | dB |
| Common Source Power Gain (Figures 1 and 9) (VDS = 15 Vdc, VGG = 10 V, f = 200 MHz, BW = 7.0 MHz (Min)) | G _{ps} | 21 | 25 | _ | dB |

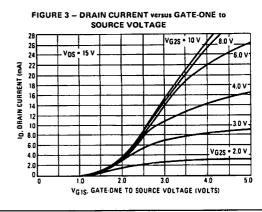
⁽¹⁾ All y-parameters are with respect to Gate 1.

FIGURE 1 - 200 MHz NOISE FIGURE AND POWER GAIN TEST CIRCUIT



TYPICAL CHARACTERISTICS





MOTOROLA SEMICONDUCTORS

FIGURE 4 – SMALL-SIGNAL COMMON-SOURCE GATE-ONE FORWARD TRANSFER ADMITTANCE versus GATE-ONE to SOURCE VOLTAGE

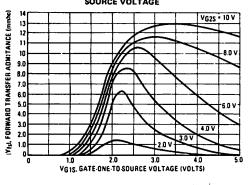


FIGURE 5 — SMALL-SIGNAL COMMON-SOURCE GATE-ONE FORWARD TRANSFER ADMITTANCE versus DRAIN CURRENT

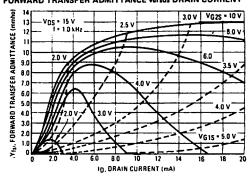


FIGURE 6 - SMALL-SIGNAL COMMON-SOURCE GATE-ONE INPUT AND OUTPUT CAPACITANCE VETSUS GATE-TWO to SOURCE VOLTAGE

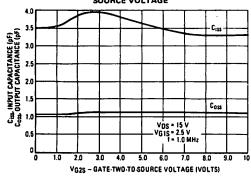


FIGURE 7 — COMMON SOURCE POWER GAIN versus

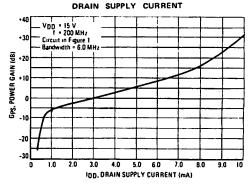


FIGURE 8 - COMMON SOURCE POWER GAIN AND SPOT NOISE FIGURE VERSUS DRAIN CURRENT

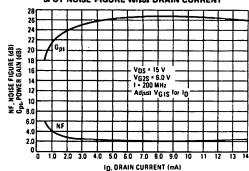
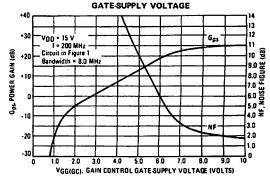
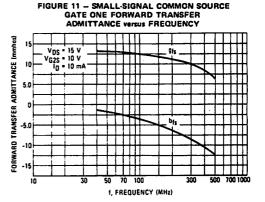


FIGURE 9 — COMMON SOURCE POWER GAIN AND SPOT NOISE FIGURE Versus GAIN CONTROL





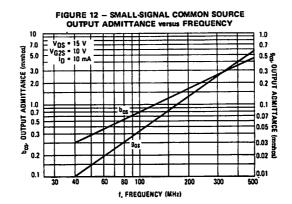
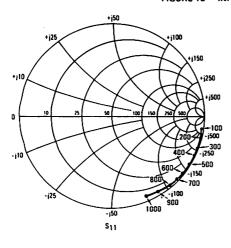
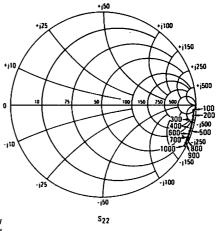


FIGURE 13 - INPUT/OUTPUT IMPEDANCE





V₀₀ = 18 V V₆₆ = 10 V I_D = 10 mA

SMALL-SIGNAL DEVICES

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

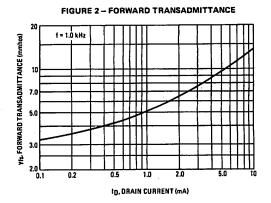
JFET RF AMPLIFIER

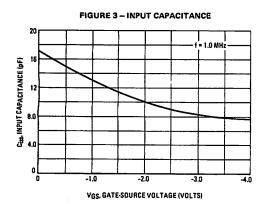
N-CHANNEL — DEPLETION

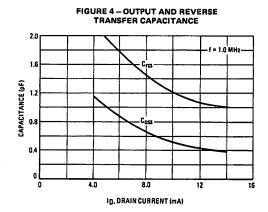
MAXIMUM RATINGS

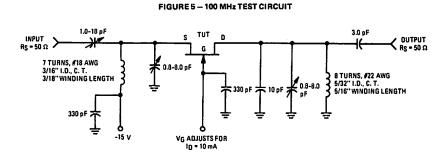
| WAXWOW RATINGS | | | | | |
|---|-----------------------------------|-------------|-------------|--|--|
| Rating | Symbol | Value | Unit | | |
| Drain-Source Voltage | V _{DS} | 25 | Vdc | | |
| Drain-Gate Voltage | V _{DG} | 25 | Vdc | | |
| Reverse Gate-Source Voltage | VGSR | 25 | Vdc | | |
| Forward Gate Current | lG(f) | 10 | mAdc | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW mW/°C | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +150 | °C | | |

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|------------------|-----|-----|-----|-------|
| OFF CHARACTERISTICS | | | | - | |
| Gate-Source Breakdown Voltage (IG = 10 µAdc, V _{DS} = 0) | V(BR)GSS | 25 | _ | _ | Vdc |
| Gate Reverse Current (VGS = 15 Vdc, VDS = 0) | IGSS | _ | _ | 5.0 | nAdc |
| Gate Source Cutoff Voltage (VDS = 15 Vdc, ID = 200 µAdc) | VGS(off) | 1 | _ | 5.0 | Vdc |
| ON CHARACTERISTICS | - | | | | |
| Zero-Gate-Voltage Drain (VDS = 15 Vdc, VGS = 0) | IDSS | 10 | | _ | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | • |
| Forward Transfer Admittance (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz) | Yfs | _ | 20 | _ | mmhos |
| Input Capacitance (V _{DS} = 15 Vdc, I _D = 10 mAdc, f = 1.0 MHz) | C _{iss} | _ | 15 | _ | pF |
| Reverse Transfer Capacitance (Vps = 15 Vdc, lp = 10 mAdc, f = 1.0 MHz) | C _{rss} | _ | 3.5 | _ | pF |
| Common-Gate Input Conductance (VDS = 15 Vdc, ID = 10 mAdc, f = 100 MHz) | gig | _ | 16 | _ | mmhos |
| Common-Gate Output Conductance (V _{DS} = 15 Vdc, I _D = 10 mAdc, f = 100 MHz) | Gog | - | - | 16 | μmhos |
| Common-Gate Forward Transadmittance (V _{DS} = 15 Vdc, I _D = 10 mAdc, f = 100 MHz) | Yfg | _ | 18 | - | mmhos |
| Common-Gate Reverse Transadmittance (VDS = 15 Vdc, ID = 10 mAdc, f = 100 MHz) | Yrg | - | _ | 130 | μmhos |
| Output Capacitance (V _{DS} = 15 Vdc, I _D = 10 mAdc, f = 1.0 kHz) | C _{oss} | _ | 3.5 | _ | pF |
| FUNCTIONAL CHARACTERISTICS | | | | | |
| Noise Figure (V _{DS} = 15 Vdc, l _D = 10 mAdc, See Figure 5) | NF | _ | | 4.0 | dΒ |
| Small-Signal Power Gain (V _{DS} = 15 Vdc, I _D = 10 mAdc, See Figure 5) | G _{pg} | _ | 11 | _ | dB |









MPF930 MPF960 MPF990

CASE 29-03, STYLE 22 TO-226AE

TMOS SWITCHING

N-CHANNEL -- ENHANCEMENT

MAXIMUM RATINGS

| INACIALOM INCLINGO | | | | | |
|--|----------------|------------|------------|--------|----------------|
| Rating | Symbol | MPF930 | MPF960 | MPF990 | Unit |
| Drain-Source Voltage | VDS | 35 | 60 | 90 | Vdc |
| Drain-Gate Voltage | VDG | 35 | 60 | 90 | Vdc |
| Gate-Source Voltage | VGS | | ± 30 | | Vdc |
| Drain Current Continuous (1) Pulsed (2) | I _D | | 2.0 3.0 | | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 8.0 | | | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, Tstg | | -55 to 15 | 60 | °C |
| Thermal Resistance | θJA | | 125 | | °C/W |

⁽¹⁾ The Power Dissipation of the package may result in a lower continuous drain current.

Min

Тур

Max

Unit

Symbol

Refer to MFE930 for graphs.

| OFF CHARACTERISTICS | | | | | <u></u> | · |
|---|----------------------------|---------------------|----------------|-------------------|-------------------|-------|
| Drain-Source Breakdown Voltage (VGS = 0, t _D = 10 μA) | MPF930 MPF960 MPF990 | V(BR)DSX | 35 60 90 | _ _ _ | <u>-</u> | Vdc |
| Gate Reverse Current (VGS = 15 Vdc, VDS = 0) | | IGSS | | _ | 50 | nAdc |
| ON CHARACTERISTICS* | | | | | | |
| Zero-Gate-Voltage Drain Current (VDS = Maximum Rating, VGS | s = 0) | l _{DSS} | - | - | 10 | μAdc |
| Gate Threshold Voltage (ID = 1.0 mA, VDS = VGS) | | VGS(Th) | 1.0 | _ | 3.5 | Vdc |
| Drain-Source On-Voltage (VGS = 10 V) (I _D = 0.5 A) | MPF930 MPF960 MPF990 | V _{DS(on)} | 111 | 0.4 0.6 0.6 | 0.7 0.8 1.0 | Vdc |
| (t _D = 1.0 A) | MPF930 MPF960 MPF990 | | = | 0.9 1.2 1.2 | 1.4 1.7 2.0 | |
| (I _D = 2.0 A) | MPF930 MPF960 MPF990 | | 111 | 2.2 2.8 2.8 | 3.0 3.5 4.0 | |
| Static Drain-Source On Resistance (VGS = 10 Vdc, ID = 1.0 Adc) | MPF930 MPF960 MPF990 | rDS(on) | 111 | 0.9 1.2 1.2 | 1.4 1.7 2.0 | Ohms |
| On-State Drain Current (VDS = 25 V, VGS = 10 V) | | ID(on) | 1.0 | 2.0 | _ | Amps |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Input Capacitance (VDS = 25 V, VGS = 0, f = 1.0 MHz) | | Ciss | | 60 | 70 | pF |
| Reverse Transfer Capacitance (VDS = 25 V, VGS = 0, f = 1.0 t | MHz) | C _{rss} | _ | 13 | 18 | pF |
| Output Capacitance (VDS = 25 V, VGS = 0, f = 1.0 MHz) | | Coss | _ | 49 | 60 | pF |
| Forward Transconductance (V _{DS} = 25 V, I _D = 0.5 A) SWITCHING CHARACTERISTICS | | 9fs | 200 | 380 | L – | mmhos |
| Turn-On Time | | ton | I – | 7.0 | 15 | ns |
| Turn-Off Time | | toff | _ | 7.0 | 15 | ns |

^{*}Pulse Test: Pulse Width \leq 300 μ s, Duty Cycle \leq 2.0%.

⁽²⁾ Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

MPF970 MPF971

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET SWITCHING

P-CHANNEL — DEPLETION

MAXIMUM RATINGS

| MINORITORI IDATINGO | | | |
|---|------------------|---------------|-------------|
| Rating | Symbol | Value | Unit |
| Drain-Source Voltage | V _{DS} | 25 | Vdc |
| Drain-Gate Voltage | VDG | 30 | Vdc |
| Reverse Gate-Source Voltage | VGSR | 30 | Vdc |
| Forward Gate Current | IG(f) | 10 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 2.8 | mW mW/°C |
| Storage Channel Temperature Range | T _{stg} | -65 to +150 | °C |
| Operating Temperature Range | Tchannel | - 65 to + 150 | °C |

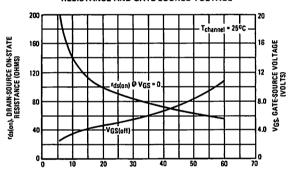
| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|--------------------------------------|-----------------------|------------|-------------|----------------|------------------------------|
| OFF CHARACTERISTICS | | | | | | |
| Gate-Source Breakdown Voltage (I _G = 1.0 μAdc, V _{DS} = 0) | | V _(BR) GSS | 30 | _ | _ | Vdc |
| Gate Reverse Current (VGS = 15 Vdc, VDS = 0) (VGS = 15 Vdc, VDS = 0, T _A = 150°C) | | IGSS | _ | _ | 1.0 1.0 | nAdc µAdc |
| Drain-Cutoff Current (VDS = 15 Vdc, VGS = 12 Vdc) (VDS = 15 Vdc, VGS = 12 Vdc, TA = 150°C) (VDS = 15 Vdc, VGS = 7.0 Vdc) (VDS = 15 Vdc, VGS = 7.0 Vdc, TA = 150°C) | MPF970 MPF970 MPF971 MPF971 | ID(off) | | _ _ _ | 10 10 10 | nAdc μAdc nAdc μAdc |
| Gate Source Cutoff Voltage (VDS = 15 Vdc, ID = 10 nAdc) | MPF970 MPF971 | VGS(off) | 5.0 1.0 | _ | 12 7.0 | Vdc |
| ON CHARACTERISTICS | | | | | | |
| Zero-Gate-Voltage Drain Current(1) (VDS = 20 Vdc, VGS = 0) | MPF970 MPF971 | loss | 15 2.0 | _ | 100 50 | mAdc |
| Drain-Source On-Voltage (I _D = 10 mAdc, V _{GS} = 0) (I _D = 1.5 mAdc, V _{GS} = 0) | | V _{DS(on)} | _ | _ | 1.5 1.5 | Vdc |
| Static Drain-Source On Resistance (ID = 1.0 mAdc, VGS = 0) | MPF970 MPF971 | ^r DS(on) | - | _ | 100 250 | Ohms |
| SMALL-SIGNAL CHARACTERISTICS | • | | | | | |
| Drain-Source "ON" Resistance (VGS = 0, ID = 0, f = 1.0 kHz) | MPF970 MPF971 | ^r ds(on) | | _ | 100 250 | Ohms |
| Input Capacitance (VGS = 12 Vdc, VDS = 0, f = 1.0 MHz) (VGS = 7.0 Vdc, VDS = 0, f = 1.0 MHz) | MPF970 MPF971 | Ciss | _ | - | 12 12 | pF |
| Reverse Transfer Capacitance (VGS = 12 Vdc, VDS = 0, f = 1.0 MHz) (VGS = 7.0 Vdc, VDS = 0, f = 1.0 MHz) | MPF970 MPF971 | C _{rss} | | _ | 5.0 5.0 | pF |

ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

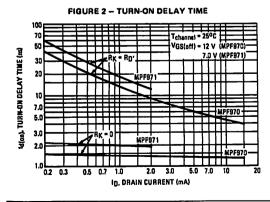
| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|------------------|--------|-----|------------|------------|------|
| SWITCHING CHARACTERISTICS (See Figure 6, RK = 0) (1 |) | | - | - | | |
| Rise Time | | tr | | | | ns |
| (ID(on) = 10 mAdc, VGS(off) = 12 Vdc) (ID(on) = 1.5 mAdc, VGS(off) = 7.0 Vdc) | MPF970 MPF971 | | | 2.0 3.0 | 5.0 5.0 | |
| Fall Time | | tę | | | | ns |
| $(I_{D(on)} = 10 \text{ mAdc}, V_{GS(off)} = 12 \text{ Vdc})$ | MPF970 | | _ | 9.0 | 15 | ļ |
| (ID(on) = 1.5 mAdc, VGS(off) = 7.0 Vdc) | MPF971 | | | 68 | 80 | |
| Turn-On Time | | ton | | | | ns |
| $(I_{D(on)} = 10 \text{ mAdc}, V_{GS(off)} = 12 \text{ Vdc})$ | MPF970 | | _ | 3.5 | 8.0 | ľ |
| (ID(on) = 1.5 mAdc, VGS(off) = 7.0 Vdc) | MPF971 | | - | 5.0 | 10 | |
| Turn-Off Time | | toff | | | | ns |
| (ID(on) = 10 mAdc, VGS(off) = 12 Vdc) | MPF970 | | - | 13 | 25 | J |
| (ID(on) = 1.5 mAdc, VGS(off) = 7.0 Vdc) | MPF971 | | - | 88 | 120 | |

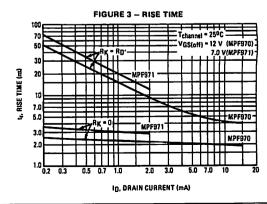
⁽¹⁾ Pulse Test: Pulse Width ≤ 100 µs, Duty Cycle ≤ 1.0%.

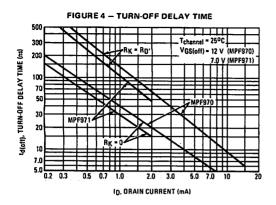




IDSS. ZERO-GATE VOLTAGE DRAIN CURRENT (mA)







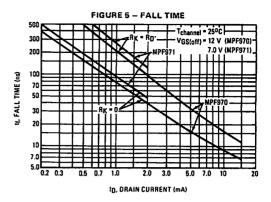
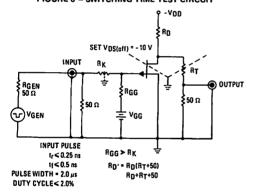


FIGURE 6 - SWITCHING TIME TEST CIRCUIT



NOTE 1

The switching characteristics shown above were measured using a test circuit similar to Figure 6. At the beginning of the switching interval, the gate voltage is at Gate Supply Voltage (+VGG). The Drain-Source Voltage (VDS) is slightly lower than Drain Supply Voltage (VDD) due to the voltage divider. Thus Reverse Transfer Capacitance (Crss) or Gate-Drain Capacitance (Crgd) is charged to VGG + VDS.

During the turn-on interval, Gate-Source Capacitance (Cgs) discharges through the series combination of RGen and RK. Cgd must discharge to VDS(on) through RG and RK in series with the parallel combination of effective load impedance (R'D) and Drain-Source Resistance (rds). During the turn-off, this charge flow is reversed.

Predicting turn on time is somewhat difficult as the channel resistance r_{ds} is a function of the gate-source voltage. While C_{gs} discharges, VGS approaches zero and r_{ds} decreases. Since C_{gd} discharges through r_{ds} , turn on time is non-linear. During turn-off, the situation is reversed with r_{ds} increasing as C_{gd} charges.

The above switching curves show two impedance conditions; 1) $R_{\rm K}$ is equal to $R_{\rm D}$, which simulates the switching behavior of cascaded stages where the driving source impedance is normally the load impedance of the previous stage, and 2) $R_{\rm K}=0$ (low impedance) the driving source impedance is that of the generator.

FIGURE 7 - TYPICAL FORWARD TRANSFER ADMITTANCE

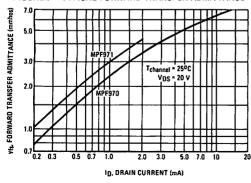


FIGURE 8 - TYPICAL CAPACITANCE

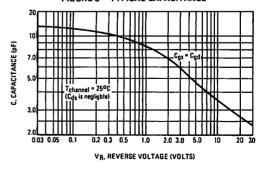


FIGURE 9 — EFFECT OF GATE-SOURCE VOLTAGE ON DRAIN-SOURCE RESISTANCE

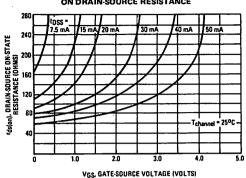


FIGURE 10 — EFFECT OF TEMPERATURE ON DRAIN-SOURCE ON-STATE RESISTANCE

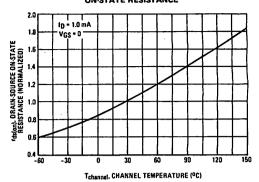
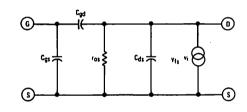


FIGURE 11 - LOW FREQUENCY CIRCUIT MODEL



Y₁₅ = jω C₁₅₅ Y₀₅ = 1/r₀₅₅ + jω C₀₅₅ Y₁₅ = .Y₁₅ Y₁₅ = -jω C₁₅₅ C₁₅₅ = C_{9d} + C₉₅ C₁₅₅ = C_{9d} + C₀₅, C_{d5} ≈ 0

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET LOW-FREQUENCY, LOW NOISE

P-CHANNEL — DEPLETION

MPF2609

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|-------------|
| Drain-Source Voltage | V _{DS} | 30 | Vdc |
| Drain-Gate Voltage | V _{DG} | 30 | Vdc |
| Gate-Source Voltage | VGS | 30 | Vdc |
| Gate Current | IG | 50 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 310 2.82 | mW mW/°C |
| Storage Temperature Range | T _{stg} | -65 to +150 | °C |

Refer to 2N5460 for graphs.

| Characteristic | | Symbol | Min | Max | Unit |
|---|--------------------|----------|----------------|---------------|-------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (I _G = 1.0 μA) | | V(BR)GSS | 30 | _ | Vdc |
| Gate Reverse Current (VGS = 5.0 Volts) | | IGSS | - | 10 | nΑ |
| Gate Source Cutoff Voltage {V _{DS} = -5.0 V, I _D = -1.0 μ A} | | VGS(off) | 1.0 | 4.0 | Vdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current (VDS = -5.0 Volts) | MPF2608 MPF2609 | lpss* | - 0.9 - 2.0 | -4.5 -10.0 | mA |
| SMALL-SIGNAL CHARACTERISTICS | • | | | | |
| Forward Transfer Admittance (VDS = -5.0 Volts, f = 1.0 kHz) | MPF2608 MPF2609 | lyfsl* | 1000 2500 | _ | μmhos |
| Input Capacitance (VDS = -5.0 Volts, VGS = 1.0 V, f = 140 kHz) | MPF2608 MPF2609 | Ciss | <u>-</u> | 17 30 | pF |
| FUNCTIONAL CHARACTERISTICS | | • | | | • |
| Noise Figure (VDS = -5.0 Volts, f = 1.0 kHz, R = 1.0 meg) | | NF | _ | 3.0 | dB |

^{*}Pulse Width < 100 msec, Duty Cycle ≤ 10%.

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET LOW-FREQUENCY, LOW NOISE

P-CHANNEL — DEPLETION

MAXIMUM RATINGS

| INTERNATION LATINGS | | | |
|---|------------------|-------------|-------------|
| Rating | Symbol | Value | Unit |
| Drain-Gate Voltage | V _{DG} | 20 | Vdc |
| Gate-Source Voltage | VGS | 20 | Vdc |
| Reverse Gate-Source Voltage | VGSR | 20 | Vdc |
| Gate Current | IG | 10 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 310 2.82 | mW mW/°C |
| Storage Temperature Range | T _{stq} | -65 to +150 | °C |

Refer to 2N5460 for graphs.

| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|------|------|-------|
| OFF CHARACTERISTICS | | | | |
| Gate-Source Breakdown Voltage (I _G = 10 μA) | V(BR)GSS | 20 | _ | Vdc |
| Gate Reverse Current (VGS = 10 V) | IGSS | _ | 10 | nA |
| Gate Source Cutoff Voltage (V _{DS} = -15 V, I _D = 10 μA) | VGS(off) | _ | 6.0 | Vdc |
| ON CHARACTERISTICS | | | | |
| Zero-Gate-Voltage Drain Current (VDS = -10 V) | loss* | 2.0 | 6.0 | mA |
| Drain-Source Resistance (lp = 100 μA, VGS = 0) | rps | 1 | 800 | Ω |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Forward Transfer Admittance (Vps = -10 V, lp = 2.0 mA, f = 1.0 kHz) | lyfsi* | 1500 | 3000 | μmhos |
| Output Admittance (Vps = -10 V, lp = 2.0 mA, f = 1.0 kHz) | lyosl | 1 | 40 | μmhos |
| Input Capacitance (Vps = -10 Volts, Vgs = 1.0 Volt, f = 1.0 MHz) | C _{iss} | 1 | 20 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | |
| Noise Figure (Vps = -5.0 V , $\text{I}_D = 1.0 \text{ mA}$, $\text{R}_G = 1.0 \text{ M}\Omega$) | NF | _ | 3.0 | dB |

^{*}Pulse Width ≤ 100 msec, Duty Cycle ≤ 10%.

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET GENERAL PURPOSE

N-CHANNEL - DEPLETION

MPF3821

| Rating | Symbol | Value | Unit |
|---|------------------|------------|-------------|
| Drain-Source Voltage | VDS | 50 | Vdc |
| Drain-Gate Voltage | V _{DG} | 50 | Vdc |
| Gate-Source Voltage | VGS | -50 | Vdc |
| Drain Current | I _D | 10 | mAdc |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 310 2.0 | mW mW/°C |
| Junction Temperature Range | TJ | 125 | ္ |
| Storage Temperature Range | T _{sta} | -65 to 150 | °C |

Refer to 2N4220 for graphs.

| ELECTRICAL CHARACTERISTICS (TA = | = 25°C unless otherwise noted.) |
|----------------------------------|---------------------------------|
|----------------------------------|---------------------------------|

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------|------------------|----------------|----------------|----------------------|
| OFF CHARACTERISTICS | | | | · | |
| Gate-Source Breakdown Voltage (IG = -1.0 µAdc, VDS = 0) | | V(BR)GSS | - 50 | _ | Vdc |
| Gate Reverse Current (VGS = -30 Vdc, VDS = 0) (VGS = -30 Vdc, VDS = 0. TA = 150°C) | | IGSS | _ | -0.1 -100 | nAdc |
| Gate Source Cutoff Voltage (I _D = 0.5 nAdc, V _{DS} = 15 Vdc) | MPF3821 MPF3822 | VGS(off) | _ | - 4.0 - 6.0 | Vdc |
| Gate Source Voltage (I _D = 50 μAdc, V _{DS} = 15 Vdc) (I _D = 200 μAdc, V _{DS} = 15 Vdc) ON CHARACTERISTICS | MPF3821 MPF3822 | V _{GS} | - 0.5 - 1.0 | - 2.0 - 4.0 | Vdc |
| Zero-Gate-Voltage Drain Current(1) (VDS = 15 Vdc, VGS = 0) | MPF3821 MPF3822 | IDSS | 0.5 2.0 | 2.5 10 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transfer Admittance (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz)(1) | MPF3821 MPF3822 | lyfsl | 1500 3000 | 4500 6500 | μmhos |
| (VDS = 15 Vdc, VGS = 0, f = 100 MHz) | MPF3821 MPF3822 | | 1500 3000 | _ | |
| Output Admittance(1) (VDS = 15 Vdc, VGS = 0, f = 1.0 kHz) | MPF3821 MPF3822 | Yos | _ | 10 20 | μmhos |
| Input Capacitance (VDS = 15 Vdc, VGS = 0, f = 1.0 MHz) | | C _{iss} | | 6.0 | pF |
| Reverse Transfer Capacitance (VDS = 15 Vdc, VGS = 0, f = 1.0 MHz) | | C _{rss} | _ | 3.0 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | | |
| Noise Figure (V _{DS} = 15 Vdc, V _{GS} = 0, R _S = 1.0 megohm, f = 10 Hz, Noise Bandwidth = 5.0 Hz) | | NF | _ | 5.0 | dB |
| Equivalent Input Noise Voltage (VDS = 15 Vdc, VGS = 0, f = 10 Hz, Noise Bandwi | dth = 5.0 Hz) | en | | 200 | nv/Hz ^{1/2} |

⁽¹⁾ Pulse Test: Pulse Width ≤ 100 ms, Duty Cycle ≤ 10%.

MPF3823 MPF3824

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET HIGH FREQUENCY AMPLIFIER

N-CHANNEL - DEPLETION

MAXIMUM RATINGS

| MAXIMON NATINGS | | | , | |
|---|------------------------|-----------------------------------|--|-------------|
| Rating | | Symbol | Value | Unit |
| Drain-Source Voltage | MPF3823 MPF3824 | V _{DS} | 30 50 | Vdc |
| Drain-Gate Voltage | MPF3823 MPF3824 | V _{DG} | 30 50 | Vdc |
| Reverse Gate-Source Volta | age MPF3823 MPF3824 | VGSR | - 30 - 50 | Vdc |
| Gate Current | | 1G | 10 | mA |
| Total Device Dissipation @ Derate above 25°C | ® T _A = 25℃ | PD | 300 2.0 | mW mW/°C |
| Lead Temperature | | TL | 300 | ౡ |
| Operating and Storage Ju Temperature Range | nction | T _J , T _{stg} | -65 to +150 | °C |

| Characteristic | | Symbol | Min | Max | Unit |
|--|--------------------|------------------|--------------|------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (IG = -1.0 μA) | MPF3823 MPF3824 | V(BR)GSS | - 30 - 50 | _ | Vdc |
| Gate Leakage Current (VGS = -20 V) | | IGSS | _ | - 0.5 | nA |
| Gate Source Cutoff Voltage (VDS = 15 V, Ip = 0.5 nA) | | VGS(off) | _ | -8.0 | Vdc |
| Gate Source Voltage (VGS = 15 V, ID = 400 μA) | | VGS | - 1.0 | -7.5 | Vdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current (VDS = 15 V) | | IDSS | 4.0 | 20 | mA |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transfer Admittance (VDS = 15 V, f = 1.0 kHz) | | lyfsl | 3500 | 6500 | μmhos |
| Output Admittance (Vps = 15 V, f = 1.0 kHz) | | lyosl | | . 35 | μmhos |
| Input Capacitance (VDS = 15 V, f = 1.0 MHz) | | C _{iss} | | 6.0 | pF |
| Reverse Transfer Capacitance (VDS = 15 V, f = 1.0 MHz) | MPF3823 MPF3824 | C _{rss} | | 2.0 3.0 | pF |
| Drain-Source "ON" Resistance (VGS = 0, I _D = 0, f = 1.0 kHz) | MPF3824 (Only) | rds(on) | | 250 | Ohms |
| FUNCTIONAL CHARACTERISTICS | | | | | |
| Noise Figure (Vps = 15 V, Vgs = 0, f = 100 MHz) | MPF3823 (Only) | NF | | 2.5 | dB |

MPF3970 MPF3971 MPF3972

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET SWITCHING

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|-------------|
| Drain-Source Voltage | VDS | 40 | Vdc |
| Drain-Gate Voltage | V _{DG} | 40 | Vdc |
| Reverse Gate-Source Voltage | VGSR | -40 | Vdc |
| Forward Gate Current | IGF | 50 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 310 2.82 | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +150 | °C |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.) Characteristic

| Characteristic | | Symbol | Min | Max | Unit |
|--|-------------------------------|---------------------|----------------------|--------------------------|------|
| OFF CHARACTERISTICS | | | | . | |
| Gate-Source Breakdown Voltage (IG = 1.0 μA, VGS = 0) | | V(BR)GSS | 40 | - | Vdc |
| Drain to Gate Leakage (VDG = 20 V, IS = 0) | | ^I DGO | _ | 250 | pA |
| Gate Reverse Current (VGS = 20 V, VDS = 0) | | IGSS | _ | 250 | pA |
| Gate Source Cutoff Voltage (VDS = -20 V, ID = 1.0 nA) | MPF3970 MPF3971 MPF3972 | VGS(off) | -4.0 -2.0 -0.5 | - 10.0 - 5.0 - 3.0 | Vdc |
| Drain Source Voltage (VGS = 0) (ID = 20 mA) (ID = 10 mA) (ID = 5.0 mA) | MPF3970 MPF3971 MPF3972 | VGS | | 1.0 1.5 2.0 | Vdc |
| Drain Cutoff Current (VDS = 20 V, VGS = -12 V) | | ID(off) | _ | 250 | pΑ |
| ON CHARACTERISTICS | | | | | - |
| Zero-Gate-Voltage Drain Current (VDS = 20 V, VGS = 0) | MPF3970 MPF3971 MPF3972 | PDSS | 50 25 5.0 | 150 75 30 | mA |
| Drain-Source "ON" Resistance (ID = 1.0 mA, V _{GS} = 0) | MPF3970 MPF3971 MPF3972 | rDS(on) | = | 30 60 100 | Ω |
| Input Capacitance (VDS = 20 V, VGS = 0, f = 1.0 MHz) | | C _{iss} | _ | 25 | pF |
| Reverse Transfer Capacitance (VDS = 0, VGS = -12 V, f = 1.0 MHz) | | C _{rss} | _ | 6.0 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | | |
| Drain-Gate Leakage (VDG = 20 V, IS = 0, TA = 150°C) | | IDGO | _ | 500 | nΑ |
| Drain Cutoff Current (VDS = 20 V, VGS = -12 V, TA = 150°C) | | ^I D(off) | _ | 500 | nA |

MPF3970, MPF3971, MPF3972

| Characteristi | c | Symbol | Min | Max | Unit |
|--|-------------------------------|--|-------------|-----------------|----------------------|
| Drain-Source "ON" Resistance (ID = 0, VGS = 0, f = 1.0 kHz) | MPF3970 MPF3971 MPF3972 | ^r ds(on) | 1 1 | 30 60 100 | Ω |
| SWITCHING CHARACTERISTICS | | | | | |
| Switching Characteristics (MPF3970 Only) (V _{DD} = 10 V, V _{GS} = 0, I _{D(on)} = 20 mA, V _{GS} | (off) = 10 V) | ^t d(on) t _r ^t off | | 10 10 30 | nsec nsec nsec |
| Switching Characteristics (MPF3971 Only) (VpD = 10 V, VgS = 0, Ip(on) = 10 mA, VgS | s(off) = 5.0 V) | ^t d(on) ^t r ^t off | _ _ _ | 15 15 60 | nsec nsec nsec |
| Switching Characteristics (MPF3972 Only) (Vnn = 10 V, Vgs = 0, In(nn) = 5.0 mA, Vg | | ^t d(on) ^t r ^t off | = | 40 40 100 | nsec nsec nsec |

CASE 29-03, STYLE 5 TO-92 (TO-226AA)

JFET SWITCHING

N-CHANNEL - DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|-------------|
| Gate-Source Voltage | VGS | -40 | Vdc |
| Gate Current | IG | 10 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 350 3.0 | mW mW/°C |
| Lead Temperature (1/16" from Case for 10 Seconds) | ΤL | 300 | °C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -55 to +150 | °C |

| Characteristic | Symbol | Min | Max | Unit |
|---|---------------------|-------|----------|----------|
| OFF CHARACTERISTICS | | | · | |
| Gate-Source Breakdown Voltage (IG = 1.0 μA, V _{DS} = 0) | V(BR)GSS | -40 | _ | Vdc |
| Gate Reverse Current (Vpg = -20 V, Is = 0) | IDGO | _ | 1.0 | nA |
| Drain-Gate Leakage (VDG = -20 V, I _S = 0, T _A = 150°C) | IDGO | _ | 400 | nA |
| Drain Cutoff Current (VDS = 20 V, VGS = -6.0 V) | ^I D(off) | _ | 1.0 | nA |
| Drain-Gate "OFF" Current (VDS = 20 V, VGS = −6.0 V, T _A = 150°C) | ID(off) | _ | 400 | nA |
| Gate 1 to Source Cutoff Voltage (Vps = 20 V, lp = 1.0 nA) | VG1S(off) | - 1.0 | - 5.0 | Vdc |
| ON CHARACTERISTICS | | | <u> </u> | 1 |
| Zero-Gate-Voltage Drain Current (VDS = 20 V, VGS = 0) | IDSS | 8.0 | _ | mA |
| Drain-Source On-Voltage (VGS = 0, I _D = 2.5 mA) | V _{DS(on)} | _ | 0.2 | Vdc |
| Static Drain-Source On Resistance (VGS = 0, I _D = 1.0 mA) (VGS = 0, I _D = 0, f = 1.0 kHz) | rDS(on) | = | 80 80 | Ω |
| SMALL-SIGNAL CHARACTERISTICS | | | · | <u> </u> |
| Input Capacitance (VDS = 20 V, VGS = 0, f = 1.0 MHz) | C _{iss} | _ | 16 | pF |
| Reverse Transfer Capacitance (Vps = 0, Vgs = -20 V, f = 1.0 MHz) | C _{rss} | _ | 5.0 | pF |
| SWITCHING CHARACTERISTICS | | | · | |
| Delay Time | t _d | _ | 20 | ns |
| Rise Time | tr | _ | 40 | ns |
| Turn-Off Time | toff | | 80 | ns |

MPF4117,A MPF4118,A MPF4119,A

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET DC AMPLIFIER TRANSISTOR

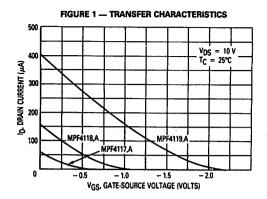
N-CHANNEL -- DEPLETION

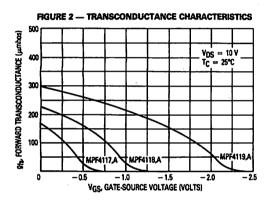
MAXIMUM RATINGS

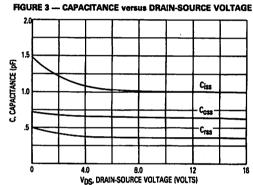
| Rating | Symbol | Value | Unit |
|---|------------------|-------------|-------------|
| Drain-Source Voltage | V _{DS} | -40 | Vdc |
| Drain-Gate Voltage | V _{DG} | - 40 | Vdc |
| Gate Current | IG | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 2.0 | mW mW/°C |
| Storage Channel Temperature Range | T _{stg} | -65 to +125 | ပ္ |

| Characteris | tic | Symbol | Min | Max | Unit |
|---|---|------------------|-------------------------|-------------------------|--------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (Vps = 0, Ig = -1.0 μAdc) | | V(BR)GSS | -40 | _ | Vdc |
| Gate Reverse Current (VGS = 20 Vdc, VDS = 0) | MPF4117, 4118, 4119 MPF4117A, 4118A, 4119A | IGSS | - | - 10 - 1.0 | pAdc . |
| (VGS = 20 Vdc, V _{DS} = 0, T _A = 125°C) | MPF4117, 4118, 4119 MPF4117A, 4118A, 4119A | | | - 25 - 2.5 | nAdc |
| Gate Source Cutoff Voltage (VDS = 10 Vdc, ID = 1.0 nAdc) | MPF4117,A MPF4118,A MPF4119,A | VGS(off) | - 0.6 - 1.0 - 2.0 | - 1.8 - 3.0 - 6.0 | Vdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current(1) (V _{DS} = 10 Vdc, V _{GS} = 0) | MPF4117,A MPF4118,A MPF4119,A | IDSS | 0.03 0.08 0.20 | 0.09 0.24 0.60 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Input Capacitance (VDS = 10 Vdc, VGS = 0, f = 1.0 MHz) | | C _{iss} | _ | 3.0 | pF |
| Reverse Transfer Capacitance (VDS = 10 Vdc, VGS = 0, f = 1.0 MHz) | | C _{rss} | 1 | 1.5 | pF |
| Common-Source Forward Transconductance (VDS = 10 Vdc, VGS = 0, f = 1.0 kHz) | MPF4117,A MPF4118,A MPF4119,A | 9fs | 70 80 100 | 210 250 330 | μmhos |
| Common-Source Output Conductance (VDS = 10 Vdc, VGS = 0, f = 1.0 kHz) | MPF4117,A MPF4118,A MPF4119.A | gos | _ | 3.0 5.0 10 | μmhos |

⁽¹⁾ IDSS is measured during a 2.0 ms interval 100 ms after power is applied.







MPF4220,A MPF4221,A MPF4222,A

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET LOW-FREQUENCY

N-CHANNEL - DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|-------------|
| Drain-Source Voltage | VDS | 30 | Vdc |
| Drain-Gate Voltage | VDG | 30 | Vdc |
| Gate-Source Voltage | VGS | 30 | Vdc |
| Reverse Gate-Source Voltage | VGSR | 30 | Vdc |
| Gate Current | IG | 10 | mA |
| Total Device Dissipation (i) T _A = 25°C Derate above 25°C | PD | 310 2.82 | mW mW/°C |
| Storage Temperature Range | T _{stq} | -65 to +150 | °C |

Refer to 2N4220 for graphs.

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Max | Unit |
|---|-------------------------------------|----------------------|-------------------------|-------------------------|-------|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage (IG = -10 µA, VDS = 0 V) | | V(BR)GSS | -30 | _ | Vdc |
| Gate Reverse Current (VGS = -15 V, VDS = 0 V) | | Igss | | - 100 | pΑ |
| Gate Source Cutoff Voltage (Vps = 15 V, Ip = 0.1 nA) | MPF4220,A MPF4221,A MPF4222,A | V _{GS(off)} | _ _ _ | -4.0 -6.0 -8.0 | Vdc |
| Gate Source Voltage (V _{DS} = 15 V, I _D = 50 μA) (V _{DS} = 15 V, I _D = 200 μA) (V _{DS} = 15 V, I _D = 500 μA) | MPF4220,A MPF4221,A MPF4222,A | V _G s | - 0.5 - 1.0 - 2.0 | - 2.5 - 5.0 - 6.0 | Vdc |
| ON CHARACTERISTICS | | | | | 1 |
| Zero-Gate-Voltage Drain Current (VDS = 15 Volts, VGS = 0 V) | MPF4220,A MPF4221,A MPF4222,A | IDSS* | + 0.5 + 2.0 + 5.0 | +3.0 +6.0 +15.0 | mA |
| SMALL-SIGNAL CHARACTERISTICS | | | | | · |
| Forward Transfer Admittance (V _{DS} = 15 V, f = 1.0 kHz, V _{GS} = 0 V) | MPF4220,A MPF4221,A MPF4222,A | Vfs * | 1000 2000 2500 | 4000 5000 6000 | μmhos |
| Output Admittance (VDS = 15 V, f = 1.0 kHz, VGS = 0 V) | MPF4220,A MPF4221,A MPF4222,A | Yos | | 10 20 40 | μmhos |
| Input Capacitance (Vps = 15 V, f = 1.0 MHz) | | C _{iss} | _ | 6.0 | pF |
| Reverse Transfer Capacitance (Vps = 15 V, f = 1.0 MHz) | | C _{rss} | _ | 2.0 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | | |
| Noise Figure (V _{DS} = 15 V, f = 100 Hz, R _G = 1.0 MΩ) | MPF4220,A MPF4221,A MPF4222,A | NF | _ | 2.5 | d₿ |

^{*}Pulse Width ≤ 100 msec, Duty Cycle ≤ 10%.

May

MPF4223 MPF4224

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET HIGH-FREQUENCY AMPLIFIER

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|----------------------|-------------|-------------|
| Drain-Source Voltage | VDS | 30 | Vdc |
| Drain-Gate Voltage | V _{DG} | 30 | Vdc |
| Drain Current | ΙD | 20 | mA |
| Gate Current | IG | 10 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 2.0 | mW mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -55 to +150 | °C |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.) Unit Characteristic Symbol Min Max **OFF CHARACTERISTICS** Gate-Source Breakdown Voltage Vdc V(BR)GSS $(I_G = -10 \mu A)$ nΑ Gate 1 Leakage Current IG1SS $(V_{G1S} = -20 V)$ MPF4223 0.25 MPF4224 0.50 Vdc **Gate Source Cutoff Voltage** VGS(off) (ID = 0.25 nA, VDS = 15 V) (ID = 0.5 nA, VDS = 15 V) -0.1 MPF4223 -8.0 MPF4224 -0.1-8.0 VGS Vdc Gate Source Voltage $(l_D = 0.3 \text{ mA, V}_{DS} = 15 \text{ V})$ $(l_D = 0.2 \text{ mA, V}_{DS} = 15 \text{ V})$ MPF4223 -1.0-7.0 MPF4224 -1.0-7.5 ON CHARACTERISTICS Zero-Gate-Voltage Drain Current mΑ IDSS MPF4223 3.0 18 $(V_{DS} = 15 V)$ MPF4224 2.0 20 **SMALL-SIGNAL CHARACTERISTICS** Forward Transfer Admittance yfs| μmhos MPF4223 3000 7000 $(V_{DS} = 15 \text{ V}, V_{GS} = 0 \text{ V}, f = 1.0 \text{ kHz})$ MPF4224 2000 7500 **Output Conductance** Re(yos) 200 μmhos (VDS = 16 V, VGS = 0 V, f = 200 MHz) Input Capacitance Ciss 6.0 (VDS = 15 V, VGS = 0 V, f = 1.0 MHz) **Reverse Transfer Capacitance** Crss рF $(V_{DS} = 15 \text{ V}, V_{GS} = 0 \text{ V}, f = 1.0 \text{ MHz})$ **FUNCTIONAL CHARACTERISTICS** NF 5.0 dB Noise Figure $(V_{DS} = 15 \text{ V}, V_{GS} = 0 \text{ V}, R_{G} = 1.0 \text{ k}\Omega, f = 200 \text{ MHz})$ MPF4223 (Only) Common Source Power Gain Gps 10 $(V_{DS} = 15 \text{ V}, V_{GS} = 0 \text{ V}, f = 200 \text{ MHz})$ MPF4223 (Only)

MPF4391 MPF4392 MPF4393

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET SWITCHING

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

| INDIAMON INTINGS | | | |
|---|--|-------------|---------------|
| Rating | Symbol | Value | Unit |
| Drain-Source Voltage | VDS | 30 | Vdc |
| Drain-Gate Voltage | V _{DG} | 30 | Vdc |
| Gate-Source Voltage | VGS | 30 | Vdc |
| Forward Gate Current | lG(f) | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 625 5.0 | mW . mW/°C |
| Operating and Storage Channel Temperature Range | T _{channel} , T _{stq} | -65 to +150 | ° |

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|-------------------------------|---------------------|-------------------|----------------|-------------------|--------------|
| OFF CHARACTERISTICS | | | | • | | |
| Gate-Source Breakdown Voltage (I _G = 1.0 μAdc, V _{DS} = 0) | | V(BR)GSS | 30 | _ | - | Vdc |
| Gate Reverse Current (VGS = 15 Vdc, VDS = 0) (VGS = 15 Vdc, VDS = 0, T _A = 100°C) | | IGSS | | = | 1.0 0.2 | πAdc μAdc |
| Drain-Cutoff Current (VDS = 15 Vdc, VGS = 12 Vdc) (VDS = 15 Vdc, VGS = 12 Vdc, T _A = 100°C) | | lD(off) | - | | 1.0 0.1 | nAdc µAdc |
| Gate Source Voltage (V _{DS} = 15 Vdc, I _D = 10 nAdc) | MPF4391 MPF4392 MPF4393 | V _{GS} | 4.0 2.0 0.5 | - | 10 5.0 3.0 | Vdc |
| ON CHARACTERISTICS | | | | | | |
| Zero-Gate-Voltage Drain Current(1) (VDS = 15 Vdc, VGS = 0) | MPF4391 MPF4392 MPF4393 | IDSS | 60 25 5.0 | | 130 75 30 | mAdc |
| Drain-Source On-Voltage (ID = 12 mAdc, VGS = 0) (ID = 6.0 mAdc, VGS = 0) (ID = 3.0 mAdc, VGS = 0) | MPF4391 MPF4392 MPF4393 | V _{DS(on)} | = | = | 0.4 0.4 0.4 | Vdc |
| Static Drain-Source On Resistance (ID = 1.0 mAdc, VGS = 0) | MPF4391 MPF4392 MPF4393 | rDS(on) | = | | 30 60 100 | Ohms |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Forward Transfer Admittance (VDS = 15 Vdc, ID = 60 mAdc, f = 1.0 kHz) (VDS = 15 Vdc, ID = 25 mAdc, f = 1.0 kHz) (VDS = 15 Vdc, ID = 5.0 mAdc, f = 1.0 kHz) | MPF4391 MPF4392 MPF4393 | lYfsl | | 20 17 12 | | mmhos |
| Drain-Source "ON" Resistance (VGS = 0, ID = 0, f = 1.0 kHz) | MPF4391 MPF4392 MPF4393 | rds(on) | - - | | 30 60 100 | Ohms |
| Input Capacitance (VGS = 15 Vdc, VDS = 0, f = 1.0 MHz) | | C _{iss} | _ | 6.0 | 10 | pF |

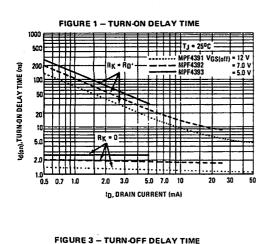
MPF4391, MPF4392, MPF4393

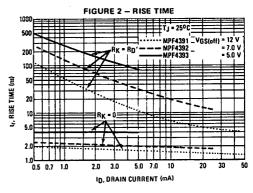
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

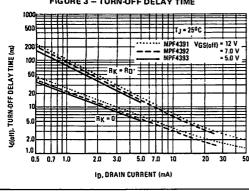
| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|-------------------------------|------------------|-------------|-------------------|-------------------|------|
| Reverse Transfer Capacitance (VGS = 12 Vdc, VDS = 0, f = 1.0 MHz) (VDS = 15 Vdc, ID = 10 mAdc, f = 1.0 MHz) | | C _{rss} | = | 2.5 3.2 | 3.5 — | pF |
| SWITCHING CHARACTERISTICS | | | | | | |
| Rise Time (See Figure 2) (ID(on) = 12 mAdc) (ID(on) = 6.0 mAdc) (ID(on) = 3.0 mAdc) | MPF4391 MPF4392 MPF4393 | t _r | _ _ _ | 1.2 2.0 2.5 | 5.0 5.0 5.0 | ns |
| Fall Time (See Figure 4) (VGS(off) = 12 Vdc) (VGS(off) = 7.0 Vdc) (VGS(off) = 5.0 Vdc) | MPF4391 MPF4392 MPF4393 | tf | _ _ _ | 7.0 15 29 | 15 20 35 | ns |
| Turn-On Time (See Figures 1 and 2) (ID(on) = 12 mAdc) (ID(on) = 6.0 mAdc) (ID(on) = 3.0 mAdc) | MPF4391 MPF4392 MPF4393 | ^t on | = | 3.0 4.0 6.5 | 15 15 15 | ns |
| Turn-Off Time (See Figures 3 and 4) (VGS(off) = 12 Vdc) (VGS(off) = 7.0 Vdc) (VGS(off) = 5.0 Vdc) | MPF4391 MPF4392 MPF4393 | ^t off | _ _ _ | 10 20 37 | 20 35 55 | ns |

⁽¹⁾ Pulse Test: Pulse Width \leq 100 μ s, Duty Cycle \leq 1.0%.

TYPICAL SWITCHING CHARACTERISTICS







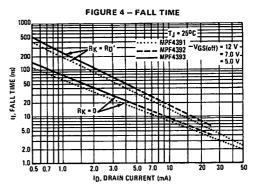
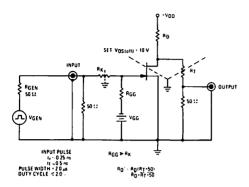


FIGURE 5 - SWITCHING TIME TEST CIRCUIT



NOTE 1

The switching characteristics shown above were measured using a test circuit similar to Figure 5. At the beginning of the switching interval, the gate voltage is at Gate Supply Voltage ($-V_{CG}$). The Drain-Source Voltage (V_{DS}) is slightly lower than Drain Supply, Voltage (V_{DD}) due to the voltage divider. Thus Reverse Transfer Capacitance (C_{rss}) or Gate-Drain Capacitance (C_{rst}) is charged to V_{CG} + V_{DS} .

VGG + VDS.

During the turn-on interval, Gate-Source Capacitance (Cgs) discharges through the series combination of RGen and R_K. Cgd must discharge to VDS(on) through RG and R_K in series with the parallel combination of effective load impedance (R'D) and Drain-Source Resistance (rds). During the turn-off, this charge flow is reversed.

Predicting turn-on time is somewhat difficult as the channel resistance r_{ds} is a function of the gate-source voltage. While C_{gs} discharges, V_{GS} approaches zero and r_{ds} decreases. Since C_{gd} discharges through r_{ds} , turn-on time is non-linear. During turn-off, the situation is reversed with r_{ds} increasing as C_{gd} charges. The above switching curves show two impedance conditions; 1)

The above switching curves show two impedance conditions; 1) $R_{\rm K}$ is equal to $R_{\rm D}$ which simulates the switching behavior of cascaded stages where the driving source impedance is normally the load impedance of the previous stage, and 2) $R_{\rm K}=0$ (low impedance) the driving source impedance is that of the generator.

FIGURE 6 - TYPICAL FORWARD TRANSFER ADMITTANCE

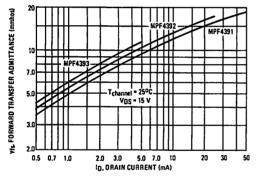


FIGURE 7 - TYPICAL CAPACITANCE

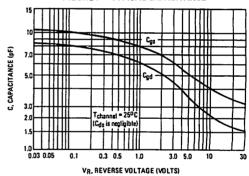


FIGURE 8 — EFFECT OF GATE-SOURCE VOLTAGE ON DRAIN-SOURCE RESISTANCE

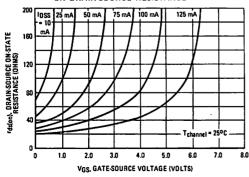
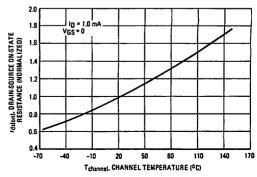
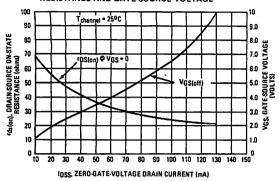


FIGURE 9 – EFFECT OF TEMPERATURE ON DRAIN-SOURCE ON-STATE RESISTANCE



MPF4391, MPF4392, MPF4393

FIGURE 10 – EFFECT OF IDSS ON DRAIN-SOURCE RESISTANCE AND GATE-SOURCE VOLTAGE



NOTE 2

The Zero-Gate-Voltage Drain Current (IDSS), is the principle determinant of other J-FET characteristics. Figure 10 shows the relationship of Gate-Source Off Voltage (VGS[off]) and Drain-Source On Resistance (rds[on]) to IDSS. Most of the devices will be within ±10% of the values shown in Figure 10. This date will be useful in predicting the characteristic variations for a given part number.

For example:

Unknown

rds(on) and VGS range for an MPF4392
The electrical characteristics table indicates that an MPF4392

The electrical characteristics table indicates that an MPF4392 has an IDSS range of 25 to 75 mA. Figure 10, shows rds(on) = 52 Ohms for IDSS = 25 mA and 30 Ohms for IDSS = 75 mA. The corresponding VGS values are 2.2 volts and 4.8 volts.

MPF4416,A

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET HIGH-FREQUENCY AMPLIFIER

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

| MAXIMOM NATINGS | | | |
|---|----------------------|--------------|-------------|
| Rating | Symbol | Value | Unit |
| Gate-Source Voltage MPF4416 MPF4416A | V _{GS} | - 30 - 35 | Vdc |
| Gate Current | lG | 10 | mA |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 300 1.7 | mW mW/°C |
| Lead Temperature | ΤĹ | 300 | °C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +150 | °C |

Symbol

Min

Unit

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic

| Onlaracterisac | | - Oyniboi | PAILTE | IVIGA | Onit |
|--|---------------------|----------------------|--------------|----------------|-------|
| OFF CHARACTERISTICS | | | - | | |
| Gate-Source Breakdown Voltage (IG = -1.0 μA) | MPF4416 MPF4416A | V(BR)GSS | - 30 - 35 | = | Vdc |
| Gate Reverse Current (VGS = -20 V) | | ^I GSS | _ | - 250 | pΑ |
| Gate Source Cutoff Voltage (VDS = 15 V, ID = 1.0 nA) | MPF4416 MPF4416A | VGS(off) | -2.5 | - 6.0 - 6.0 | Vdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current* (VDS = 15 V) | | DSS | 5.0 | 15 | mA |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Forward Transfer Admittance (VDS = 15 V, f = 1.0 kHz) | | Yfs | 4500 | 7500 | μmhos |
| Input Admittance (V _{DS} = 15 V, f = 100 MHz) (V _{DS} = 15 V, f = 400 MHz) | | Re(y _{is}) | = | 100 1000 | μmhos |
| Output Admittance (VDS = 15 V, f = 1.0 kHz) | | lyosl | - | 50 | μmhos |
| Output Conductance (V _{DS} = 15 V, f = 100 MHz) (V _{DS} = 15 V, f = 400 MHz) | | Re(y _{OS}) | = | 75 100 | μmhos |
| Forward Transconductance* (VDS = 15 V, f = 400 MHz) | | Re(yfs) | 4000 | | μmhos |
| Input Capacitance (V _{DS} = 15 V, f = 1.0 MHz) | | C _{iss} | _ | 4.0 | pF |
| Reverse Transfer Capacitance (Vps = 15 V, f = 1.0 MHz) | | C _{rss} | _ | 0.8 | ρF |
| Output Capacitance (VDS = 15 V, f = 1.0 MHz) | | Coss | - | 2.0 | pF |
| FUNCTIONAL CHARACTERISTICS | | | | | |
| Noise Figure (V _{DS} = 15 V, I _D = 5.0 mA, R _G = 1.0 k Ω , f = 100 MHz) (V _{DS} = 15 V, I _D = 5.0 mA, R _G = 1.0 k Ω , f = 400 MHz) | | NF | - | 2.0 4.0 | dB |
| Common Source Power Gain (VDS = 15 V, ID = 5.0 mA, f = 100 MHz) (VDS = 15 V, ID = 5.0 mA, f = 400 MHz) | | G _{ps} | 18 10 | = | dB |

MPF4856,A thru

CASE 29-02, STYLE 5 TO-92 (TO-226AA)

JFET SWITCHING

N-CHANNEL -- DEPLETION

MPF4861,A

| Rating | Symbol | MPF4857,A | MPF4859,A MPF4860,A MPF4861,A | Unit |
|---|------------------|-----------|-------------------------------------|------|
| Drain-Source Voltage | Vos | +40 | +30 | Vdc |
| Drain-Gate Voltage | VDG | +40 | +30 | Vdc |
| Reverse Gate-Source Voltage | VGSR | -40 | -30 | Vdc |
| Forward Gate Current | lGF | 5 | mAdc | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 3 2 | mW mW/°C | |
| Storage Temperature Range | T _{stg} | - 65 te | င့ | |

MAXIMUM RATINGS

Refer to 2N4856 for graphs.

| Charact | eristic | Symbol | Min | Max | Unit |
|--|--|---------------------|------------|------------|--|
| OFF CHARACTERISTICS | | | | | |
| Gate-Source Breakdown Voltage | | V(BR)GSS | | | Vdc |
| (IG = 1.0 μAdc, VDS = 0) | MPF4856,A, MPF4857,A, MPF4858,A MPF4859,A, MPF4860,A, MPF4861,A | | -40 -30 | | |
| Gate Reverse Current | | IGSS | | | |
| $(V_{GS} = -20 \text{ Vdc}, V_{DS} = 0)$ | MPF4856,A, MPF4857,A, MPF4858,A | 1 | | 0.25 | nAdc |
| (VGS = -15 Vdc, VDS = 0) | MPF4859,A, MPF4860,A, MPF4861,A | 1 | _ | 0.25 | ــــــــــــــــــــــــــــــــــــــ |
| (VGS = -20 Vdc, VDS = 0, TA = 150°C (VGS = -15 Vdc, VDS = 0, TA = 150°C | | | _ | 0.5 0.5 | μAdc |
| |) WIFF4655,A, WIFF4600,A, WIFF4601,A | V-21 | | | Vdc |
| Gate Source Cutoff Voltage (Vps = 15 Vdc, lp = 0.5 nAdc) | MPF4856,A, MPF4859,A | VGS(off) | -4.0 | - 10 | Vac |
| (VDS = 15 Vdc, ID = 0.5 HAdc) | MPF4857,A, MPF4860,A | 1 | - 2.0 | -6.0 | 1 |
| | MPF4858,A, MPF4861,A | 1 | -0.8 | -4.0 | ļ |
| Drain Cutoff Current | | ^I D(off) | | | |
| (VDS = 15 Vdc, VGS = -10 Vdc) | |) 5,5, | _ | 0.25 | nAdc |
| (VDS = 15 Vdc, VGS = -10 Vdc, TA = | 150°C) | | | 0.5 | μAdc |
| ON CHARACTERISTICS | | | | | |
| Zero-Gate-Voltage Drain Current(1) | | IDSS | | | mAdc |
| (VDS = 15 Vdc, VGS = 0) | MPF4856,A, MPF4859,A | 1 1 | 50 | _ | |
| | MPF4857,A, MPF4860,A | 1 | 20 | 100 | |
| | MPF4858,A, MPF4861,A | | 8.0 | 80 | |
| Drain-Source On-Voltage | | V _{DS(on)} | | | Vdc |
| (ID = 20 mAdc, VGS = 0) | MPF4856,A, MPF4859,A | 1 | - | 0.75 | |
| (ID = 10 mAdc, VGS = 0) (ID = 5.0 mAdc, VGS = 0) | MPF4857,A, MPF4860,A MPF4858,A, MPF4861,A | | _ | 0.5 0.5 | |
| SMALL-SIGNAL CHARACTERISTICS | WIFF4030,A, WIFF4001,A | 1 1 | | 0.5 | L |
| Drain-Source "ON" Resistance | | rds(on) | | | Ohms |
| (VGS = 0, ID = 0, f = 1.0 kHz) | MPF4856,A, MPF4859,A | 'us(on) | | 25 | 0 |
| (103 0) 0) 1 | MPF4857,A, MPF4860,A | | _ | 40 | |
| | MPF4858,A, MPF4861,A | | | 60 | |
| Input Capacitance | | Ciss | | | pF |
| (VDS = 0, VGS = -10 Vdc, f = 1.0 MHz | |] | - | 18 | 1 |
| | MPF4856A thru MPF4861A | | | 10 | <u> </u> |
| Reverse Transfer Capacitance | | Crss | | | pF |
| (VDS = 0, VGS = -10 Vdc, f = 1.0 MH; | | } | | | |
| | 4856 thru MPF4861 | | _ | 8.0 | |
| MPI | 4856A, MPF4859A | 1 | _ | 4.0 | 1 |

MPF4856,A thru MPF4861,A

| | Characteristic | | Symbol | Min | Max | Unit |
|-----------------------|---|--|--------------------|---|---------------------------------------|------|
| SWITCHING CH | ARACTERISTICS | | | | | |
| Turn-On Delay Time | Conditions for MPF4856,A, MPF4859,A: (VDD = 10 Vdc, l _{D(on)} = 20 mAdc, VGS(on) = 0, VGS(off) = -10 Vdc) | MPF4856, MPF4859 MPF4856A, MPF4859A MPF4857, MPF4860 MPF4857A, MPF4860A MPF4858, MPF4861 MPF4858A, MPF4861A | ^t d(on) | = | 6.0 5.0 6.0 6.0 10 8.0 | กร |
| Rise Time | Conditions for MPF4857,A, MPF4860,A: (VDD = 10 Vdc, !D(on) = 10 mAdc, VGS(on) = 0, VGS(off) = -6.0 Vdc) | MPF4856,A, MPF4859,A MPF4857,A, MPF4860,A MPF4858, MPF4861 MPF4858A, MPF4861A | t _r | | 3.0 4.0 10 8.0 | ns |
| Turn-Off Time | Conditions for MPF4858,A, MPF4861,A: (VDD = 10 Vdc, !D(on) = 5.0 mAdc, VGS(on) = 0, VGS(off) = -4.0 Vdc) | MPF4856, MPF4859 MPF4856A, MPF4859A MPF4857, MPF4860 MPF4857A, MPF4861 MPF4858A; MPF4861 MPF4858A; MPF4861A | ^t off | | 25 20 50 40 100 80 | ns |

⁽¹⁾ Pulse Test: Pulse Width = 100 ms, Duty Cycle ≤ 10%.

⁽²⁾ The ID(on) values are nominal; exact values vary slightly with transistor parameters.

U308 U309 U310

CASE 27-02, STYLE 4 TO-52 (TO-206AC)

JFET VHF/UHF AMPLIFIER

N-CHANNEL -- DEPLETION

MAXIMUM RATINGS

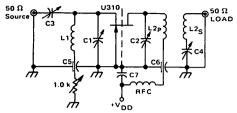
| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|-------------|
| Drain-Source Voltage | V _{DS} | 25 | Vdc |
| Gate-Source Voltage | VGS | 25 | Vdc |
| Gate Current | l _G | 20 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | ₽D | 500 4.0 | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +150 | ů |

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|----------------------|--------------------|-------------------------|--------------|----------------------|----------|
| OFF CHARACTERISTICS | | | | | | |
| Gate-Source Breakdown Voltage (IG = 1.0 μA, VDS = 0) | | V(BR)GSS | - 25 | - | <u> </u> | V |
| Gate Reverse Current (VGS = -15 V) (VGS = 0, TA = 125°C) | | IGSS | | - | 150 150 | pA nA |
| Gate Source Cutoff Voltage (VDS = 10 V, ID = 1.0 nA) | U308 U309 U310 | VGS(off) | - 1.0 - 1.0 - 2.5 | <u>-</u> | -6.0 -4.0 -6.0 | v |
| ON CHARACTERISTICS | | | | | | |
| Zero-Gate-Voltage Drain Current(1) (VDS = 10 V, VGS = 0) | U308 U309 U310 | IDSS | 12 12 24 | - - - | 60 30 60 | mA |
| Gate-Source Forward Voltage (IG = 10 mA, VDS = 0) | | V _{GS(f)} | | _ | 1.0 | ٧ |
| SWITCHING CHARACTERISTICS | | | | | | , |
| Common-Gate Forward Transconductance(1) (VDS = 10 V, ID = 10 mA, f = 1.0 kHz) | U308 U309 U310 | 9fg | 10 10 10 | _ _ _ | 20 20 18 | mmhos |
| Common-Gate Output Conductance (VDS = 10 V, tp = 10 mA, f = 1.0 kHz) | | gog | _ | 150 | | μmhos |
| Drain-Gate Capacitance (VGS = -10 V, VDS = 10 V, f = 1.0 MHz) | | C _{gd} | _ | | 2.5 | pF |
| Gate-Source Capacitance (VGS = -10 V, VDS = 10 V, f = 1.0 MHz) | | Cgs | _ | _ | 5.0 | pF |
| Equivalent Short-Circuit Input Noise Voltage (VDS = 10 V, ID = 10 mA, f = 100 Hz) | | ēn | _ | 10 | | nV√Hz |

⁽¹⁾ Pulse test duration = 2.0 ms.

⁽²⁾ See Figures 10 and 11 for Noise Figure and Power Gain information.

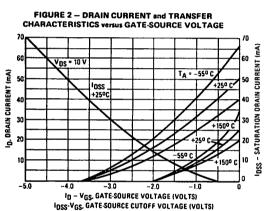
FIGURE 1 - 450 MHz COMMON-GATE AMPLIFIER TEST CIRCUIT

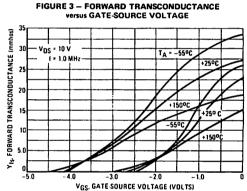


C1 = C2 = 0.8 -- 10 pF, JFD #MVM010W. C3 = C4 = 8-35 pF Erie #539-002D.

C5 = C6 = 5000 pF Eria +359 0020. C7 = 1000 pF. Allen Bradley #FA5C RFC = 0.33 µH Miller #9230-30.

.1 = One Turn #16 Cu, 1/4" I.D. (Air Core). L1 = One Turn #16 Cu, 1/4" I.D. (Air Core). L2p= One Turn #16 Cu, 1/4" I.D. (Air Core). L2s = One Turn #16 Cu, 1/4" I.D. (Air Core).





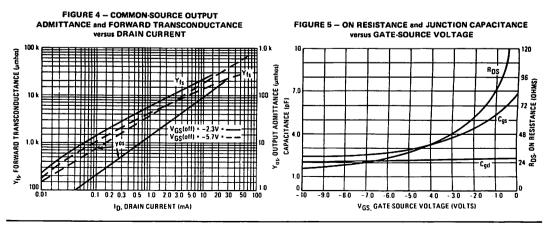


FIGURE 6 – COMMON-GATE Y PARAMETER
MAGNITUDE versus FREQUENCY

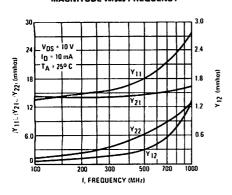


FIGURE 7 - COMMON-GATE S PARAMETER

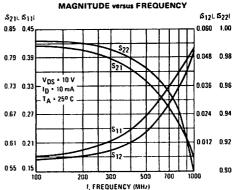


FIGURE 8 – COMMON-GATE Y PARAMETER
PHASE-ANGLE versus FREQUENCY

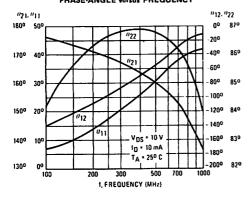


FIGURE 9 - S PARAMETER PHASE-ANGLE

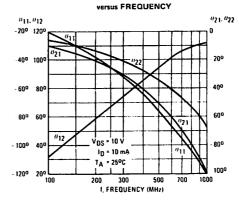


FIGURE 10 - NOISE FIGURE and POWER GAIN VOISUS DRAIN CURRENT

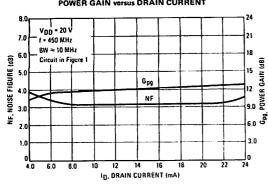
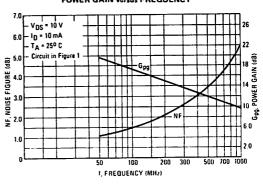
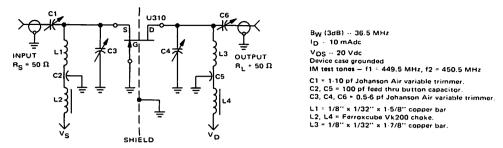


FIGURE 11 — NOISE FIGURE and POWER GAIN versus FREQUENCY



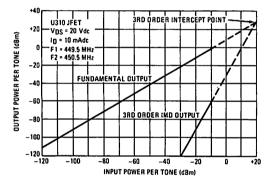
MOTOROLA SEMICONDUCTORS

FIGURE 12 - 450 MHz IMD EVALUATION AMPLIFIER



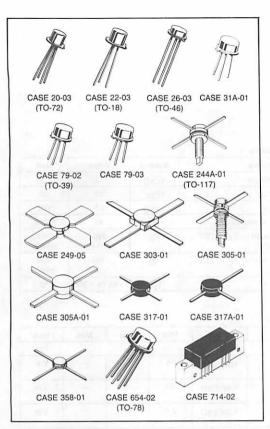
Amplifier power gain and IMD products are a function of the load impedance. For the amplifier design shown above with C4 and C6 adjusted to reflect a load to the drain resulting in a nominal power gain of 9 dB, the 3rd order intercept point (IP) value is 29 dBm. Adjusting C4, C6 to provide larger load values will result in higher gain, smaller bandwidth and lower IP values. For example, a nominal gain of 13 dB can be achieved with an intercept point of 19 dBm.

FIGURE 13 - TWO TONE 3RD ORDER INTERCEPT POINT



Example of intercept point plot use:

Assume two in-band signals of -20 dBm at the amplifier input. They will result in a 3rd order IMD signal at the output of -90 dBm. Also, each signal leval at the output will be -11 dBm, showing an amplifier gain of 9.0 dB and an intermodulation ratio (IMR) capability of 79 dB. The gain and IMR values apply only for signal levels below compression.



Small-signal high-frequency transistors and hybrid modules from Motorola are characterized as low-noise amplifiers, oscillators, high-speed switches, Class A linear amplifiers, and Class C amplifiers. Packaging options include plastic/ceramic stripline and metal can.

RF Transistors

2N2857 2N3839

2N2857 JAN, JTX, JTXV AVAILABLE CASE 20-03, STYLE 10 TO-72 (TO-206AF)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MAXIMON DATINGS | | | |
|---|------------------|-------------|-------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 15 | Vdc |
| Collector-Base Voltage | VCBO | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 2.5 | Vdc |
| Collector Current — Continuous | lc | 40 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 200 1.14 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 300 1.72 | mW mW/°C |
| Storage Temperature | T _{stq} | -65 to +200 | °C |

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|----------------------|-----------------------|--------------|------------|----------------|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage* (IC = 3.0 mAdc, Ig = 0) | | V(BR)CEO | 15 | 1 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 1.0 µAdc, IE = 0) | | V _(BR) CBO | 30 | _ | | Vdc |
| (I _E = 10 µAdc, I _C = 0) | | V(BR)EBO | 2.5 | ı | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 15 Vdc, I _E = 0) (V _{CB} = 15 Vdc, I _E = 0, T _A = 150°C) | Both Types 2N3839 | СВО | 1-1 | 11 | 0.01 1.0 | μAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain (IC = 3.0 mAdc, VCE = 1.0 Vdc) | | μŁΕ | 30 | 1 | 150 | _ |
| SMALL SIGNAL CHARACTERISTICS | | | | | | _ |
| Current-Gain — Bandwidth Product(1) (I _C = 5.0 mAdc, V _{CE} = 6.0 Vdc, f = 100 MHz) | 2N2857 2N3839 | fτ | 1000 1000 | 1 1 | 1900 2000 | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, I _E = 0, f = 0.1 to 1.0 MHz) | | C _{cb} | _ | 0.7 | 1.0 | pF |
| Small Signal Current Gain (I _C = 2.0 mAdc, V _{CE} = 6.0 Vdc, f = 1.0 kHz) | | h _{fe} | 50 | _ | 220 | _ |
| Collector Base Time Constant (IE = 2.0 mAdc, V _{CB} = 6.0 Vdc, f = 31.9 MHz) | 2N2857 2N3839 | rb'C _C | 4.0 1.0 | = | 15 15 | ps |
| Noise Figure (Figure 1) $(I_E=0.1 \text{ mAdc}, V_{CE}=1.0 \text{ Vdc}, R_S=50 \text{ ohms}, f=450 \text{ MHz})(2) (I_C=1.5 \text{ mAdc}, V_{CE}=6.0 \text{ Vdc}, R_S=50 \text{ ohms}, f=450 \text{ MHz})$ | | NF | 1 | 5.8 4.1 | 4.5 3.9 | dB |
| FUNCTIONAL TEST | | | | | | |
| Common-Emitter Amplifier Power Gain (Figure 1) (I _E = 0.1 mAdc, V_{CE} = 1.0 Vdc, f = 450 MHz, R_S = 50 Ω)/(2) (I _C = 1.5 mAdc, V_{CE} = 6.0 Vdc, f = 450 MHz, R_S = 50 Ω) | | Gpe | _ 12.5 | 11 — | _ 19 | dB |
| Power Output (Figure 2) (IE = 12 mAdc, VCB = 10 Vdc, f = 500 MHz) | | Pout | 30 | _ | _ | mW |

⁽¹⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.

⁽²⁾ Micro-Power Specifications.

^{*}Indicates Data in addition to JEDEC Requirements.

FIGURE 1 - TEST CIRCUIT FOR NOISE FIGURE AND POWER GAIN L3 ٤uع C4 0.3-5.0 Rs = 50 12

FIGURE 2 - TEST CIRCUIT FOR OSCILLATOR POWER OUTPUT Capacitance values in pF 50 11 DOUBLE STUB TUNER (+) VCC O L1 - 3 turns #16 AWG wire, 3/8" O.D. 1-1/4" long.

- L1, L2 Silver-plated brass rod, 1-1/2" long and 1/4" dia. Install at least 1/2" from nearest vertical chassis surface.
 - L3 1/2 turn #16 AWG wire, located 1/4" from and
 - parallel to L.2.

 External interlead shield to isolate collector lead from emitter and base leads.
 - utralization Procedure (A) Connect 450-MHz signal generator (with Rs = 50 ohms) to input terminals of amplifier. (B) Connect 50-ohm RF voltmeter ecross output terminals of amplifier.
- Apply VEE, and with signal generator adjusted for 5 mV output from amplifler, tune C1, C3, and C4 for maximum output.

 Interchange connections to signal generator and
- (E)
- With sufficient signal applied to output terminals of amplifier, adjust C2 for minimum indication at input.
- Repeat steps (A), (B), and (C) to determine if retuning

FIGURE 3 - NOISE FIGURE versus FREQUENCY

10 VCE = 6.0 Vdc 9.0 1c = 1.0 mAdc 8.0 As = Optimum ~ 250 Ohms @ 105 and 200 MHz ~ 100 Ohms @ 450 MHz 7.0 6.0 5.0 4.0 3.0 1.0 60 70 50 100 200 300 400 . 500 f, FREQUENCY (MHz)

FIGURE 4 - NOISE FIGURE VERSUS SOURCE RESISTANCE AND COLLECTOR CURRENT

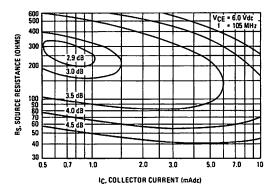


FIGURE 5 - NOISE FIGURE versus SOURCE RESISTANCE AND COLLECTOR CURRENT

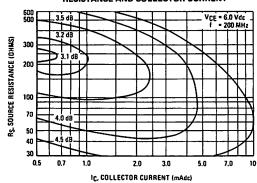


FIGURE 6 — CURRENT-GAIN— BANDWIDTH PRODUCT

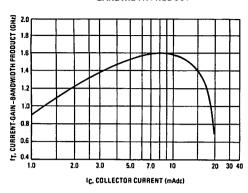


FIGURE 7 – NOISE FIGURE AND POWER GAIN
WEIGHT COLLECTOR CURRENT

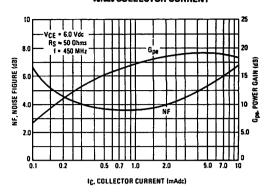


FIGURE 8 - INPUT ADMITTANCE

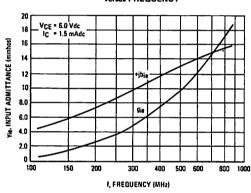


FIGURE 9 — OUTPUT ADMITTANCE
Versus FREQUENCY

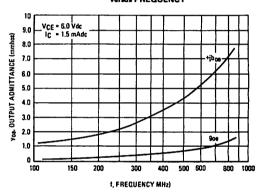


FIGURE 10 - FORWARD TRANSFER
ADMITTANCE versus FREQUENCY

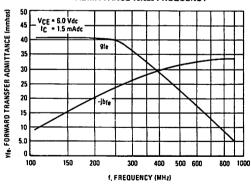


FIGURE 11 -REVERSE TRANSFER
ADMITTANCE VERSUS FREQUENCY

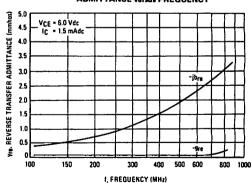


FIGURE 12 - S₁₁, INPUT REFLECTION COEFFICIENT FIGURE 13 - S₂₂, OUTPUT REFLECTION COEFFICIENT

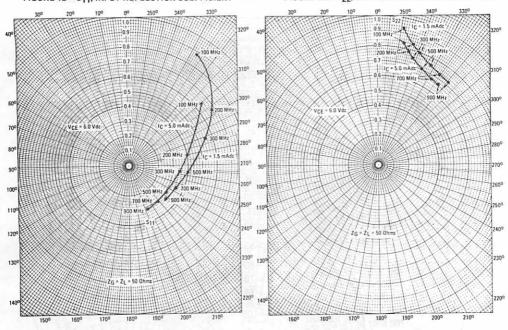


FIGURE 14 – S₁₂, REVERSE TRANSMISSION COEFFICIENT FIGURE 15 – S₂₁, FORWARD TRANSMISSION COEFFICIENT

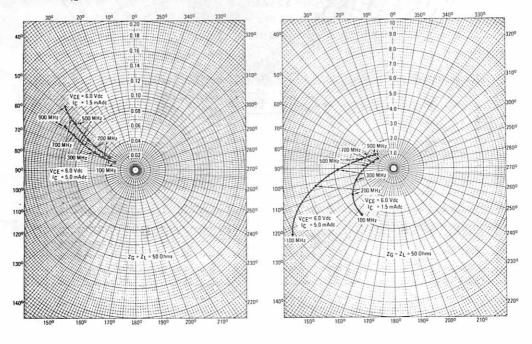
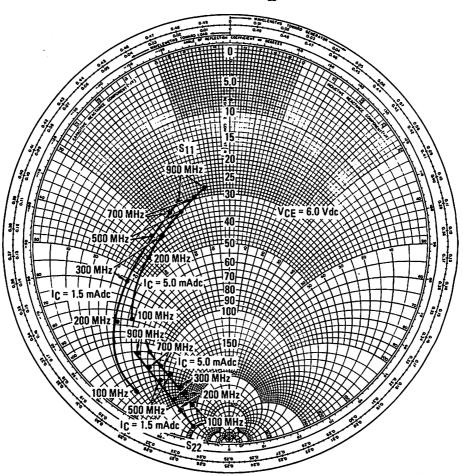


FIGURE 16 - S₁₁, INPUT REFLECTION COEFFICIENT AND S₂₂, OUTPUT REFLECTION COEFFICIENT



2N3553

JAN, JTX, JTXV AVAILABLE CASE 79-02, STYLE 1 TO-39 (TO-205AD)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MANIMON IDATINGO | | | |
|--|------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 65 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | lc | 1.0 | Adc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 7.0 40 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | TJ, Tstg | -65 to +200 | ္င |

| ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise | noted.) | | | | |
|--|------------------|-----|----------|------------|------|
| Characteristic | Symbol | Min | Тур | Max | Unit |
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Sustaining Voltage(1) (IC = 200 mAdc, Ig = 0) | VCEO(sus) | 40 | - | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 0.1 mAdc, I _C = 0) | V(BR)EBO | 4.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCE = 30 Vdc, IB = 0) | ¹ CEO | _ | | 0.1 | mAdc |
| Collector Cutoff Current (VCE = 30 Vdc, VBE(off) = 1.5 Vdc, T _C = 200°C) (VCE = 65 Vdc, VBE(off) = 1.5 Vdc) | ICEX | - | _ | 5.0 1.0 | mAdc |
| Emitter Cutoff Current (VBE = 4.0 Vdc, IC = 0) | lEBO | _ | | 0.1 | mAdc |
| ON CHARACTERISTICS | | | | т | |
| DC Current Gain (I _C = 250 mAdc, V _{CE} = 5.0 Vdc) | ptE | 10 | _ | | _ |
| Collector-Emitter Saturation Voltage (IC = 250 mAdc, Ig = 50 mAdc) | VCE(sat) | _ | <u> </u> | 1.0 | Vdc |
| SMALL SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 100 mAdc, VCE = 28 Vdc, f = 100 MHz) | fT | _ | 500 | _ | MHz |
| Output Capacitance (VCB = 30 Vdc, Ig = 0, f = 100 kHz) | C _{obo} | _ | 8.0 | 10 | pF |
| FUNCTIONAL TEST (FIGURE 2) | | | | | |
| Amplifier Power Gain (VCE = 28 Vdc, Pout = 2.5 Watts, f = 175 MHz) | G _{pe} | 10 | | _ | dB |
| Collector Efficiency (VCE = 28 Vdc, Pout = 2.5 Watts, f = 175 MHz) | η | 50 | _ | _ | % |
| Power Input (VCE = 28 Vdc, P _{out} = 2.5 Watts, f = 175 MHz) | Pin | | | 0.25 | Watt |

(1) Pulsed thru a 25 mH inductor.

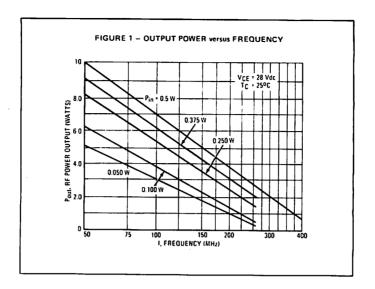
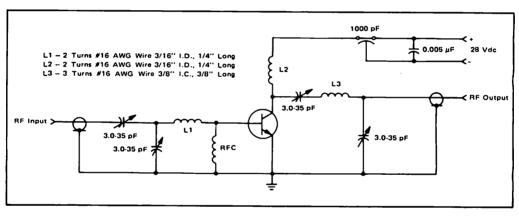


FIGURE 2 - 175 MHz TEST CIRCUIT SCHEMATIC



2N3839 For Specifications, See 2N2857 Data.

2N3866 2N3866A

JAN, JTX, JTXV AVAILABLE CASE 79-02, STYLE 1 TO-39 (TO-205AD)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 30 | Vdc |
| Collector-Base Voltage | V _{CBO} | 55 | Vdc |
| Emitter-Base Voltage | VEBO | 3.5 | Vdc |
| Collector Current — Continuous | lc | 0.4 | Adc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | Watts mW/°C |
| Storage Temperature | T _{stg} | -65 to +200 | .€ |

| Characteristic | | Symbol | Min | Max | Unit |
|---|---------------------------|------------------|-----------------|----------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 5.0 mAdc, R _{BE} = 10 Ω) | | VCER(sus) | 55 | _ | Vdc |
| Collector-Emitter Sustaining Voltage (I _C = 5.0 mAdc, I _B = 0) | | VCEO(sus) | 30 | _ | Vdc |
| Emitter-Base Breakdown Voltage (Ig = 100 μAdc, IC = 0) | | V(BR)EBO | 3.5 | - | Vdc |
| Collector Cutoff Current (VCE = 28 Vdc, I _B = 0) | | ICEO | - | 0.02 | mAdc |
| Collector Cutoff Current (VCE = 30 Vdc, VBE = -1.5 Vdc (Rev.), T _C = 200°C) (VCE = 55 Vdc, VBE = -1.5 Vdc (Rev.) | | ICEX | - | 5.0 0.1 | mAdc |
| Emitter Cutoff Current (VBE = 3.5 Vdc, IC = 0) | | IEBO | _ | 0.1 | mAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 360 mAdc, V_{CE} = 5.0 Vdc) (I _C = 50 mAdc, V_{CE} = 5.0 Vdc) | Both 2N3866 2N3866A | hFE | 5.0 10 25 | 200 200 | _ |
| Collector-Emitter Saturation Voltage (IC = 100 mAdc, IB = 20 mAdc) | | VCE(sat) | _ | 1.0 | Vdc |
| SMALL SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 15 Vdc, f = 200 MHz) | 2N3866 2N3866A | fT | 500 800 | | MHz |
| Output Capacitance (VCB = 28 Vdc, Ig = 0, f = 1.0 MHz) | | C _{obo} | _ | 3.0 | pF |
| FUNCTIONAL TEST (FIGURE 1) | | | | | |
| Amplifier Power Gain (VCC = 28 Vdc, P _{out} = 1.0 W, f = 400 MHz) | | G _{pe} | 10 | _ | dB |
| Collector Efficiency (VCC = 28 Vdc, P _{out} = 1.0 W, f = 400 MHz) | | η | 45 | | % |

FIGURE 1 - 400 MHz TEST CIRCUIT SCHEMATIC

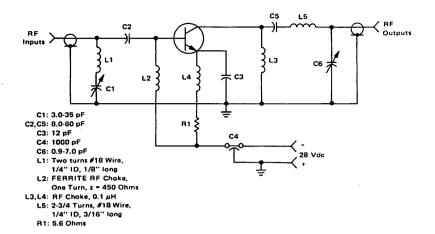


FIGURE 2 - POWER OUTPUT versus FREQUENCY (Class C)

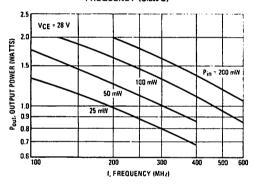


FIGURE 3 - CURRENT-GAIN - BANDWIDTH PRODUCT

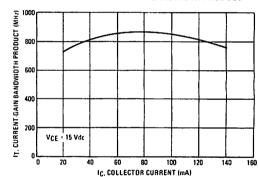


FIGURE 4 - COLLECTOR-BASE TIME CONSTANT

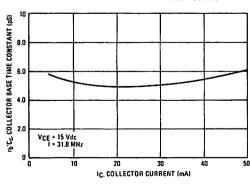


FIGURE 5 - OUTPUT CAPACITANCE

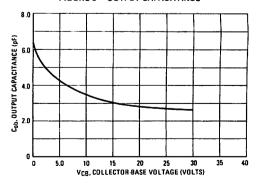


FIGURE 6 — OUTPUT POWER versus INPUT POWER (CLASS C)

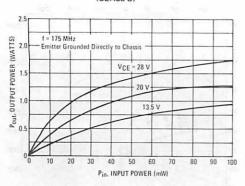


FIGURE 7 - SMALL-SIGNAL CURRENT GAIN

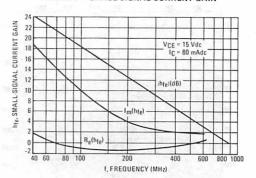


FIGURE 8 – LARGE-SIGNAL SERIES EQUIVALENT IMPEDANCES

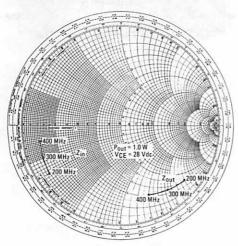
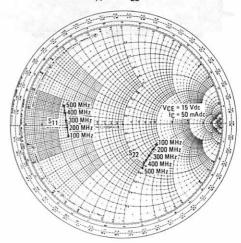
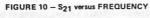


FIGURE 9 - S₁₁ AND S₂₂ versus FREQUENCY

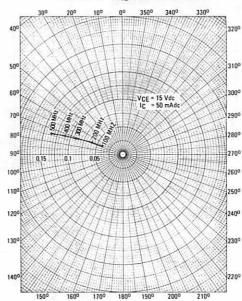




320° 500 3100 300° VCE = 15 Vdc IC = 50 mAdc

2900

FIGURE 11 - S₁₂ versus FREQUENCY



MAXIMUM RATINGS

| MAXIMOM TATILOO | | | | |
|---|----------------------|-------------|---------------|--|
| Rating | Symbol | Value | Unit | |
| Collector-Emitter Voltage | VCEO | 20 | Vdc | |
| Collector-Base Voltage | VCBO | 36 | Vdc | |
| Emitter-Base Voltage | VEBO | 3.5 | Vdc | |
| Collector Current — Continuous | lc | 400 | mAdc | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.71 | Watt mW/°C | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | ů | |

THERMAL CHARACTERISTICS

| | Characteristic | Symbol | Max | Unit |
|---|---|--------|-----|------|
| ı | Thermal Resistance, Junction to Case | ReJC | 35 | °C/W |
| | Thermal Resistance, Junction to Ambient | RAJA | 175 | °C/W |

2N3948

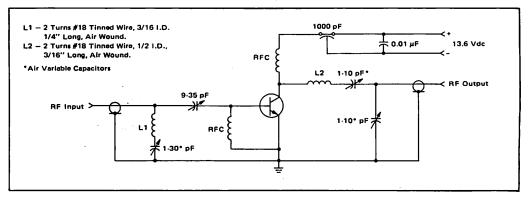
CASE 79-02, STYLE 1 TO-39 (TO-205AD)

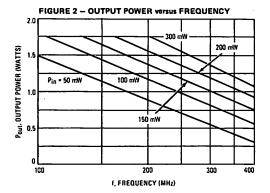
HIGH FREQUENCY TRANSISTOR

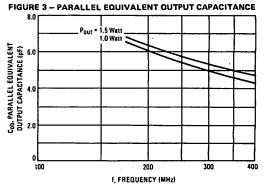
NPN SILICON

| | Characteristic | Symbol | Min | Max | Unit |
|---|---|-----------------------|-----|------------|------|
| OFF CHARACTERISTIC | s | | | | |
| Collector-Emitter Susta | | VCEO(sus) | 20 | - | Vdc |
| Collector-Base Breakdo | | V _(BR) CBO | 36 | _ | Vdc |
| Emitter-Base Breakdow (IE = 0.1 mAdc, IC = | | V(BR)EBO | 3.5 | _ | Vdc |
| Collector Cutoff Curren (VCB = 15 Vdc, IE = (VCB = 15 Vdc, IE = | 0) | ICBO | = | 0.1 100 | μAdc |
| ON CHARACTERISTICS | 3 | | | | |
| DC Current Gain (IC = 50 mAdc, VCE | = 5.0 Vdc) | hFE | 15 | _ | - |
| SMALL SIGNAL CHAR | ACTERISTICS | | | | |
| Current-Gain — Bandw (IE = 50 mAdc, VCE | ridth Product = 15 Vdc, f = 200 MHz) | fΤ | 700 | | MHz |
| Output Capacitance (VCB = 15 Vdc, IE = | 0, f = 1.0 MHz) | C _{obo} | _ | 4.5 | pF |
| FUNCTIONAL TEST (F | IGURE 1) | | | | |
| Power Gain | | Gpe | 6.0 | | ₫B |
| Output Power | (V _{CC} = 13.6 Vdc, f = 400 MHz, P _{in} = 0.25 W) | Pout | 1.0 | _ | Watt |
| Collector Efficiency | 7 | n | 45 | | % |

FIGURE 1 - 400 MHz RF AMPLIFIER TEST CIRCUIT







MAXIMUM RATINGS

| MAXIMOM NATINGS | | | |
|---|----------------------|-------------|-------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 12 | Vdc |
| Collector-Base Voltage | VCBO | 20 | Vdc |
| Emitter-Base Voltage | VEBO | 4.5 | Vdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 400 2.3 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 750 4.3 | mW mW/°C |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|-------|-------|
| Thermal Resistance, Junction to Case | Resc | 0.233 | °C/mW |
| Thermal Resistance, Junction to Ambient | ReJA | 0.436 | °C/mW |

2N3959 2N3960

JAN, JTX, JTXV AVAILABLE CASE 22-03, STYLE 1 TO-18 (TO-206AA)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|------------------|---------------------|----------------|---------------|--------------|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, I _B = 0) | | V(BR)CEO | 12 | _ | | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | | V(BR)CBO | 20 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 10 μAdc, I _C = 0) | | V(BR)EBO | 4.5 | _ | _ | Vdc |
| Collector Cutoff Current (VCE = 10 Vdc, VEB = 2.0 Vdc) (VCE = 10 Vdc, VEB = 2.0 Vdc, TA = 150°C) | | ICEX | _ | 1 | 0.005 5.0 | μAdc |
| Collector Forward Current (VCE = 5.0 Vdc, VBE = 0.4 Vdc) | | ICEX | - | _ | 1.0 | μAdc |
| Base Cutoff Current (VCE = 10 Vdc, VEB = 2.0 Vdc) | | IBL | 1 | _ | 0.005 | μAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain (I _C = 1.0 mAdc, V _{CE} = 1.0 Vdc) (I _C = 10 mAdc, V _{CE} = 1.0 Vdc) (I _C = 30 mAdc, V _{CE} = 1.0 Vdc) | | hFE | 25 40 25 | <u>-</u> - | | |
| Collector-Emitter Saturation Voltage (I _C = 1.0 mAdc, I _B = 0.1 mAdc) (I _C = 30 mAdc, I _B = 3.0 mAdc) | | VCE(sat) | - | _ | 0.2 0.3 | Vdc |
| Base-Emitter On Voltage (IC = 1.0 mAdc, V _{CE} = 1.0 Vdc) (IC = 30 mAdc, V _{CE} = 1.0 Vdc) | , | V _{BE(on)} | | | 0.8 1.0 | Vdc |
| SMALL SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product (I _C = 5.0 mAdc, V _{CE} = 4.0 Vdc, f = 100 MHz) | 2N3959 2N3960 | fτ | 1000 1300 | = | = | MHz |
| $(I_C = 10 \text{ mAdc, V}_{CE} = 10 \text{ Vdc, f} = 100 \text{ MHz})$ | 2N3959 2N3960 | | 1300 1600 | _ | = | |
| (I _C = 30 mAdc, V_{CE} = 4.0 Vdc, f = 100 MHz) | 2N3959 2N3960 | | 1000 1200 | = | _ | |
| Output Capacitance (VCB = 4.0 Vdc, Ip = 0, f = 1.0 MHz) | | Cobo | _ | 2.0 | 2.5 | pF |

2N3959 • 2N3960

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|------------------|-------------------|-----|-----|----------|------|
| Input Capacitance (VEB = 0.5 Vdc, IC = 0, f = 100 MHz) | | C _{ibo} | | 1.5 | 2.5 | pF |
| Collector Base Time Constant (IC = 5.0 mAdc, VCE = 4.0 Vdc) | 2N3959 2N3960 | rb'C _C | = | = | 30 50 | ps |
| (LC = 10 mAdc, VCE = 10 Vdc) | 2N3959 2N3960 | | _ | } = | 25 40 | |
| (I _C = 30 mAdc, V _{CE} = 4.0 Vdc) | 2N3959 2N3960 | | _ | _ | 30 50 | |

SWITCHING CHARACTERISTICS (FIGURE 7)

| Turn-On Delay Time | td(on) | | ns |
|--|--------------|------------|-----|
| (I _C = 10 mAdc, V _{out} = 1.0 Vdc) | - 2.4 | ! — | 1 ! |
| (IC = 30 mAdc, V _{out} = 1.0 Vdc) | _ 2.0 | 1 – | |
| Rise Time | tr | 1 | ns |
| (IC = 10 mAdc, Vout = 1.0 Vdc) Both Device | es — 3.0 | i – | 1 1 |
| (IC = 30 mAdc, V _{out} = 1.0 Vdc) 2N3959 | | t — | |
| 2N3960 | | | 1 1 |
| Turn-Off Delay Time | td(off) | | ns |
| (IC = 10 mAdc, V _{out} = 1.0 Vdc) | - 1.6 | - | ļ |
| (IC = 30 mAdc, V _{out} = 1.0 Vdc) | — 1.6 | | |
| Fall Time | tf | | ns |
| (IC = 10 mAdc, Vout = 1.0 Vdc) Both Devi | es — 3.3 | J — | 1 |
| (IC = 30 mAdc, V _{out} = 1.0 Vdc) 2N3959 | _ 2.3 | \ – | 1 1 |
| 2N3960 | - 1.9 | _ | |

FIGURE 1 - TYPICAL DC CURRENT GAIN

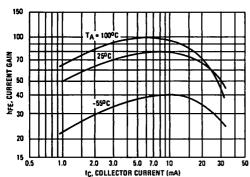


FIGURE 3 - TYPICAL COLLECTOR-BASE TIME CONSTANT

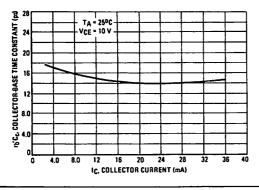


FIGURE 2 – TYPICAL CURRENT-GAIN – BANDWIDTH PRODUCT

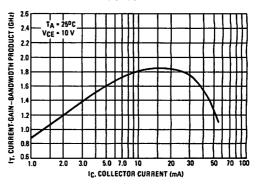
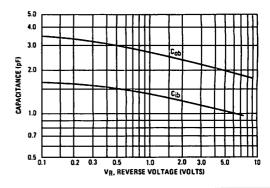
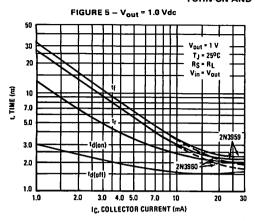


FIGURE 4 - TYPICAL JUNCTION CAPACITANCE



TURN-ON AND TURN-OFF TIMES



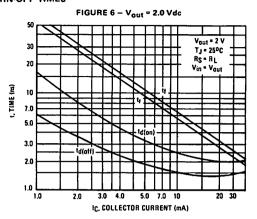
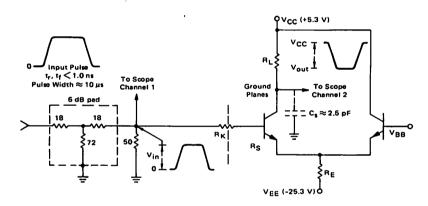


FIGURE 7 - SWITCHING TIMES TEST CIRCUIT



This test set up is designed to simulate a cascade of identical stages. ..The source resistance $\{R_g\}$ equals the load resistance $\{R_L\}$. Values used in the test are shown in the table.

For V_{in} = V_{out} = 1 V, V_{BB} = +0.5 V, R_L & R_K values appropriately reduced.

| Vin = Vout = 2 volts, VBB = +1.0V | | | | | |
|-----------------------------------|--------|--------------------|--------------------|--|--|
| I _C (mA) | R∈(kΩ) | R _L (Ω) | R _K (Ω) | | |
| 1.0 | 24.0 | 2.0 k | 2.0 k | | |
| 3.0 | 8.2 | 680 | 680 | | |
| 10 | 2.4 | 200 | 180 | | |
| 30 | 0.8 | 68 | 36 | | |

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAYIMLIM RATINGS

| MAXIMUM KATINGS | | | |
|---|------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Base Voltage | VCBO | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 2.0 | Vdc |
| Base Current | lΒ | 400 | mAdc |
| Collector Current — Continuous | lc | 400 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.71 | Watt mW/℃ |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 3.5 20 | Watts mW/°C |
| Storage Temperature | T _{stg} | -65 to +200 | °C |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|--------------|------------|------|
| OFF CHARACTERISTICS | | | · | |
| Collector-Emitter Sustaining Voltage (IC = 5.0 mAdc, RgE = 10 ohms) | VCER(sus) | 40 | _ | Vdc |
| Collector-Emitter Sustaining Voltage (I _C = 5.0 mAdc, I _B = 0) | VCEO(sus) | 20 | - | Vdc |
| Collector Cutoff Current (VCE = 12 Vdc, lp = 0) | ¹ CEO | - | 0.02 | mAdc |
| Collector Cutoff Current (VCE = 40 Vdc, VBE = -1.5 Vdc) (VCE = 12 Vdc, VBE = -1.5 Vdc, TC = +150°C) | ICEV | - | 0.1 5.0 | mAdc |
| Emitter Cutoff Current (VEB = 2.0 Vdc, IC = 0) | lEBO | _ | 0.1 | mAdc |
| ON CHARACTERISTICS | | | , | , |
| DC Current Gain (IC = 100 mAdc, V _{CE} = 5.0 Vdc) (IC = 360 mAdc, V _{CE} = 5.0 Vdc) | hFE | 10 5.0 | 200 — | _ |
| Collector-Emitter Saturation Voltage { c = 100 mAdc, g = 20 mAdc} | VCE(sat) | _ | 0.5 | Vdc |
| SMALL SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (I _C = 50 mAdc, V _{CE} = 15 Vdc, f = 200 MHz) | fT | 500 | _ | MHz |
| Output Capacitance (V _{CB} = 12 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | | 4.0 | ρF |
| FUNCTIONAL TEST (FIGURE 2) | | | | |
| Common-Emitter Amplifier Power Gain (Pin = 100 mW, V _{CC} = 12 Vdc, f = 175 MHz) | G _{pe} | 10 | _ | dB |
| Collector Efficiency (Pout = 1.0 W, VCC = 12 Vdc, f = 175 MHz) | η | 50 | _ | % |
| Power Input (Pout = 1.0 W, VCC = 12 Vdc, f = 175 MHz) | Pin | _ | 100 | mW |

FIGURE 1 - POWER OUTPUT versus FREQUENCY

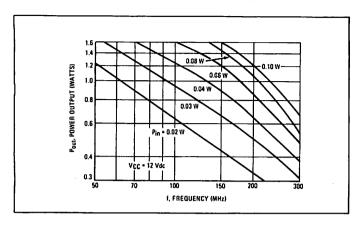
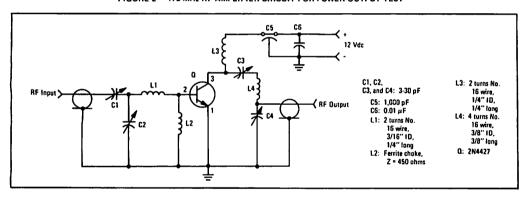


FIGURE 2 - 175 MHz RF AMPLIFIER CIRCUIT FOR POWER-OUTPUT TEST



2N4957 2N4958 2N4959 2N5829

2N4957 JAN, JTX, JTXV AVAILABLE CASE 20-03, STYLE 10 TO-72 (TO-206AF)

HIGH FREQUENCY TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| MAXIMUM KATINGS | | | |
|---|----------------------|-------------|------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 30 | Vdc |
| Collector-Base Voltage | V _{CBO} | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | ¹c | 30 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 200 1.14 | mW mW/℃ |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | ပို |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|--------------------------------------|-------------------|----------------|--------------------------|--------------------------|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, IB = 0) | | V(BR)CEO | 30 | - | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 μAdc, I _E = 0) | | V(BR)CBO | 30 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 3.0 | | _ | Vdc |
| Collector Cutoff Current (VCB = 10 Vdc, IE = 0) (VCB = 10 Vdc, IE = 0, TA = 150°C) | | СВО | _ | _ | 0.1 100 | μAdc |
| ON CHARACTERISTICS | | | | , | | |
| DC Current Gain (IC = 2.0 mAdc, VCE = 10 Vdc) | | hFE | 20 | 40 | 150 | |
| SMALL SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product(1) (IE = 2.0 mAdc, VCE = 10 Vdc, f = 100 MHz) | 2N4957, 2N5829 2N4958, 2N4959 | fT | 1200 1000 | 1600 1500 | 2500 2500 | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | | C _{cb} | _ | 0.4 | 0.8 | pF |
| Small Signal Current Gain (IC = 2.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | | h _{fe} | 20 | _ | 200 | _ |
| Collector Base Time Constant (IE = 2.0 mAdc, VCB = 10 Vdc, f = 63.6 MHz) | | rb'C _C | 1.0 | _ | 8.0 | ps |
| Noise Figure (Figure 1) (IC = 2.0 mAdc, VCE = 10 Vdc, f = 450 MHz) | 2N5829 2N4957 2N4958 2N4959 | NF | _ _ _ | 2.3 2.6 2.9 3.2 | 2.5 3.0 3.3 3.8 | dB |
| FUNCTIONAL TEST | | | | | | |
| Common-Emitter Amplifier Power Gain (Figure 1) (VCE = 10 Vdc, IC = 2.0 mAdc, f = 450 MHz) | 2N4957, 2N5829 2N4958 2N4959 | Gpe | 17 16 15 | <u>-</u> | 25 25 25 | dB |

⁽¹⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.

FIGURE 1 – NOISE FIGURE AND POWER GAIN TEST CIRCUIT

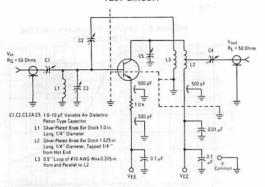


FIGURE 3 - NOISE FIGURE versus FREQUENCY

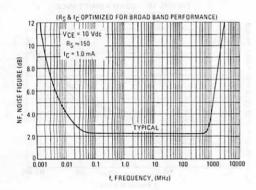


FIGURE 5 — CONTOURS OF NOISE FIGURE versus SOURCE RESISTANCE AND COLLECTOR CURRENT

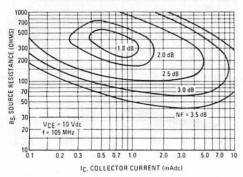


FIGURE 2 – UNILATERALIZED POWER GAIN versus FREQUENCY

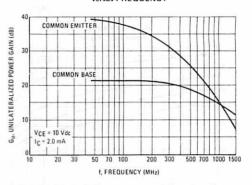


FIGURE 4 – NOISE FIGURE AND POWER GAIN versus COLLECTOR CURRENT

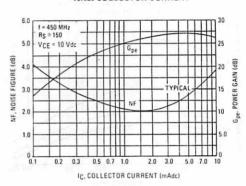
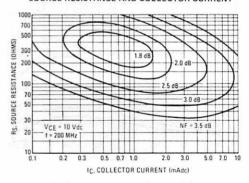
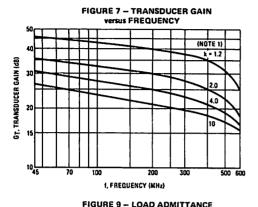


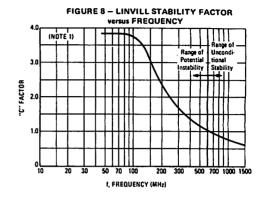
FIGURE 6 — CONTOURS OF NOISE FIGURE versus SOURCE RESISTANCE AND COLLECTOR CURRENT

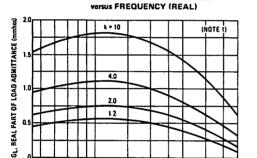


COMMON EMITTER CIRCUIT DESIGN DATA

(VCF = 10 Vdc, IC = 2.0 mAdc)

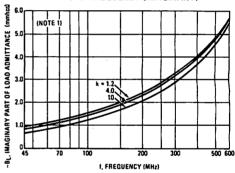


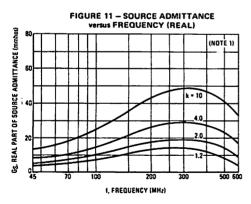


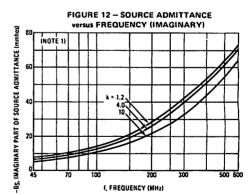


f, FREQUENCY (MHz)









NOTE 1 Figures 7 through 18 are included to assist the circuit designer in determin ing the stability of his particular circuit. Two stability criteria are given in these figures.

The Linvill "C" factor* is a measure of transistor stability when the input and output are terminated in the worst-case (open circuit) condition. When

* "Transistors and Active Circuits," Linvill and Gibbons, McGraw Hill, 1961.

"C" is less than 1.0, the circuit is unconditionally stable. When "C" is greater

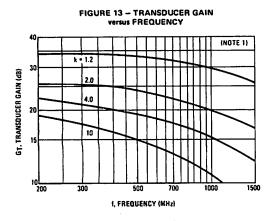
than 1.0, the circuit is potentially unstable.

The Stern "K" factor! has been defined to determine the stability of a practical amplifier terminated in finite load and source admittances. If "K" is greater than 1.0, the circuit will be stable. If less than 1.0, the circuit will be unstable. For further details, see Application Note AN-215A.

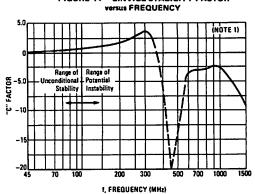
Stability and Power Gain of Tuned Transistor Amplifiers," Arthur P. Stern, Proc. I.R.E., March 1967

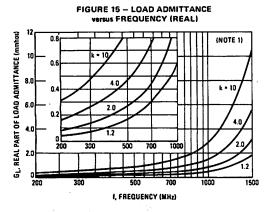
COMMON BASE CIRCUIT DESIGN DATA

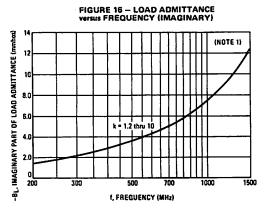
(VCB = 10 Vdc, IC = 2.0 mAdc)

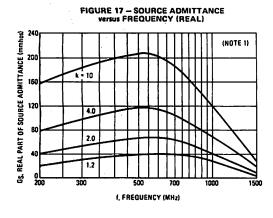


2N4957 • 2N4958 • 2N4959 • 2N5829









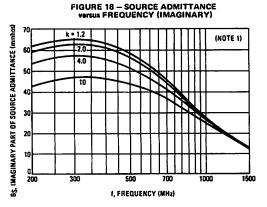


FIGURE 19 – SMALL-SIGNAL CURRENT GAIN FIGURE 20 – POLAR ho versus FREQUENCY 32 1500 MHz 1000 . V_{CE} = 10 Vdc I_C = 2.0 mA 21 -4.0 GAIN hfe (dB) 300 -60 200 SMALL-SIGNAL CURRENT -8 n 20 -10 -12 (H FE) (H FE) (H FE) (H FE) (H FE) -Im (hfe) 75 -20 -22 4.0 VCE = 10 Vdc -24 hfe, Re (hfe) -26 Ic = 2.0 mA -28 -30 20 30 10 50 70 100 200 300 500 700 1000 1500 -6.0 -4.0 -2.0 0 2.0 4.0 6.0 8.0 10 12 f, FREQUENCY (MHz) Re (hfe) FIGURE 21 - fT versus COLLECTOR CURRENT FIGURE 22 - DC CURRENT GAIN BANDWIDTH PRODUCT (GHz) 2.0 V_{CE} = 10 Vdc 1.8 1.6 DC CURRENT GAIN 50 1.4 1.2 CURRENT-GAIN-0.8 0.6 0.4 VCE = 10 Vdc 0.2 ÷ 0.2 0.3 0.5 0.7 1.0 2.0 3.0 5.0 7.0 10 30 50 70 100 IC, COLLECTOR CURRENT (mAdc). IC. COLLECTOR CURRENT (mAdc) FIGURE 23 - CAPACITANCE FIGURE 24 - COLLECTOR CHARACTERISTICS 3.0 TC = 250C (pF) VERTICAL SCALE CAPACITANCE Ic = 1.0 mA/DIV 0.5 Ccb 0.3 Ib = 0.02 mA/STEP N 2 0.2 0.5 20 5.0 50 HORIZONTAL SCALE - VCE = 1.0 V/DIV REVERSE VOLTAGE (VOLTS) Apply reverse bias between collector Apply reverse bias between emitter Apply reverse bias between collector and base and measure capacitance and base and measure capacitance and base and measure capacitance

between these terminals. Emitter is

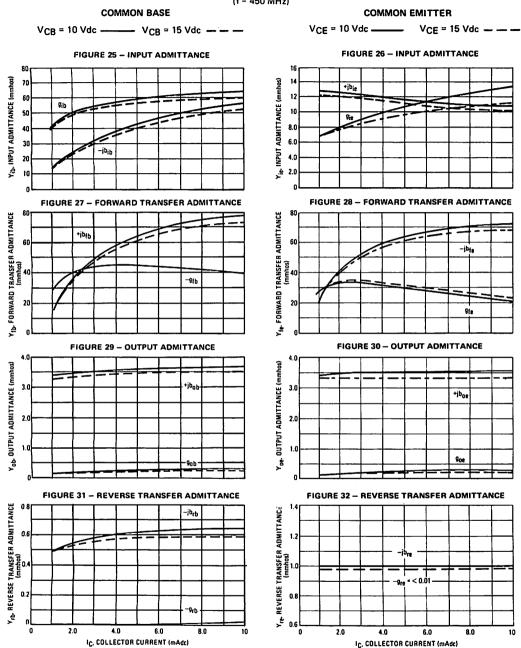
between these terminals. Emitter is

guarded.

between these terminals. Collector is

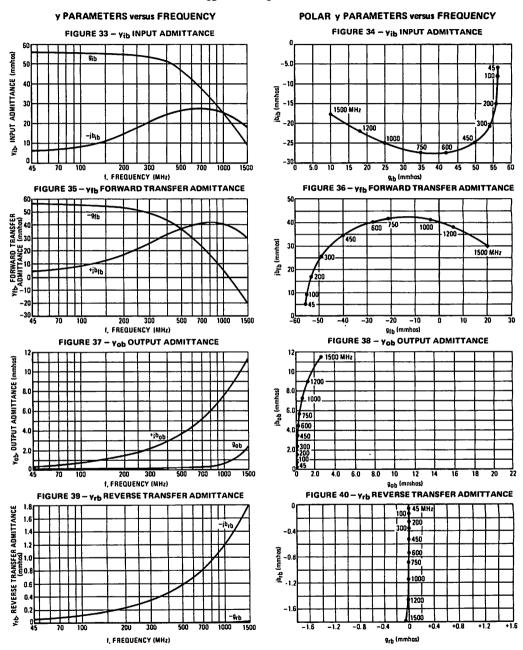
open.

Y PARAMETERS versus CURRENT (f = 450 MHz)



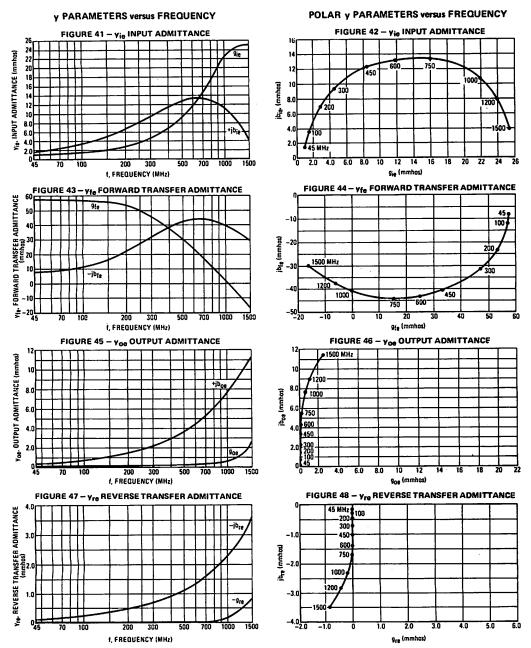
COMMON BASE y PARAMETER VARIATIONS

(VCB = 10 Vdc, IC = 2.0 mAdc)



COMMON EMITTER y PARAMETER VARIATIONS

(VCE = 10 Vdc, IC = 2.0 mAdc)



2N5031 2N5032

CASE 20-03, STYLE 10 TO-72 (TO-206AF)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MACHINE TEATHER | | | |
|---|-----------------------------------|-------------|-------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 10 | Vdc |
| Collector-Base Voltage | V _{CBO} | 15 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | įc | 20 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 200 1.14 | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|------------------|----------------------|------|-----|------------|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) | | V(BR)CEO | 10 | 1 | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.01 mAdc, IE = 0) | | V(BR)CBO | 15 | _ | 1 | Vdc |
| (I _E = 0.01 mAdc, I _C = 0) | | V _{(BR)EBO} | 3.0 | - | _ | Vđc |
| Collector Cutoff Current (VCB = 6.0 Vdc, I _E = 0) | · | Iсво | - | 1.0 | 10 | nAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain (IC = 1.0 mAdc, VCE = 6.0 Vdc) | | hFE | 25 | _ | 300 | _ |
| SMALL SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product (IC = 5.0 mAdc, VCE = 6.0 Vdc, f = 100 MHz) | | fΤ | 1000 | _ | 3500 | MHz |
| Collector-Base Capacitance (VCE = 6.0 Vdc, I _E = 0, f = 0.1 MHz) | | C _{cb} | ı | 1.3 | 1.5 | pF |
| Collector Base Time Constant (IC = 6.0 mAdc, VCE = 6.0 Vdc, f = 31.8 MHz) | | rb'C _C | ı | 5.0 | _ | ps |
| Noise Figure (Figure 1) (IC = 1.0 mAdc, VCE = 6.0 Vdc, f = 450 MHz) | 2N5031 2N5032 | NF | - | | 2.5 3.0 | dВ |
| FUNCTIONAL TEST | | | | | | |
| Common-Emitter Amplifier Power Gain (Figure 1) (VCE = 6.0 Vdc, IC = 1.0 mAdc, f = 450 MHz) | | Gpe | 14 | 17 | 25 | dB |

2N5031 • 2N5032

FIGURE 1 - POWER GAIN AND NOISE FIGURE TEST CIRCUIT

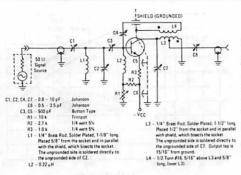


FIGURE 2 - COLLECTOR-BASE CAPACITANCE versus VOLTAGE

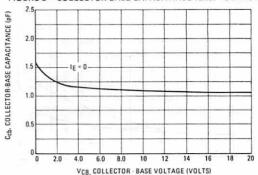
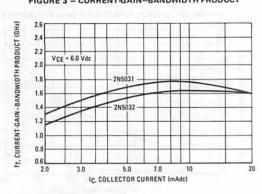


FIGURE 3 - CURRENT-GAIN-BANDWIDTH PRODUCT



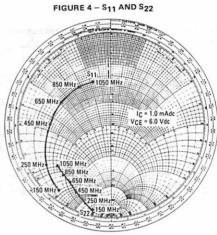


FIGURE 5 - S12 0.09

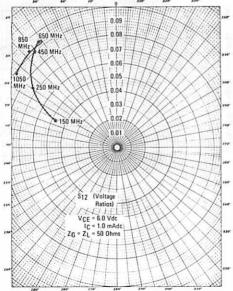


FIGURE 6 - S21

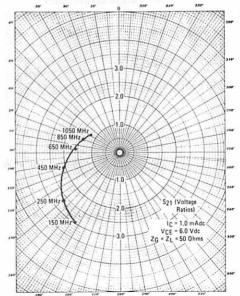


FIGURE 7 - NOISE FIGURE versus FREQUENCY

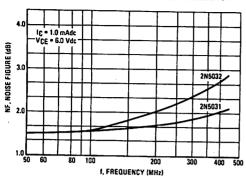


FIGURE 8 - POWER GAIN versus FREQUENCY

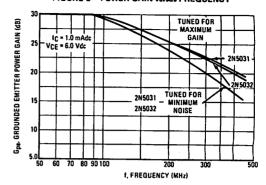


FIGURE 9 - INPUT ADMITTANCE versus FREQUENCY

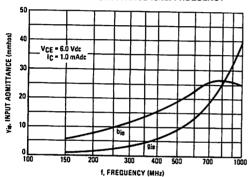


FIGURE 10 - OUTPUT ADMITTANCE versus FREQUENCY

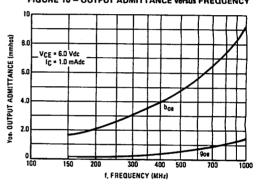


FIGURE 11 - FORWARD TRANSFER

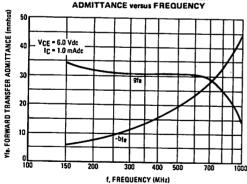
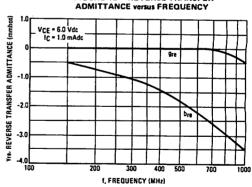


FIGURE 12 - REVERSE TRANSFER



CASE 79-02, STYLE 1 TO-39 (TO-205AD)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

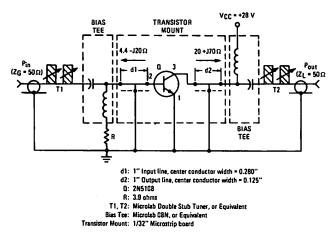
MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 30 | Vdc |
| Collector-Emitter Voltage (R _{BE} = 10Ω) | VCER | 55 | Vdc |
| Collector-Base Voltage | V _{CBO} | 55 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | lc | 0.4 | Adc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 3.5 0.02 | Watts mW/°C |
| Storage Temperature | T _{sta} | -65 to +200 | °C |

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

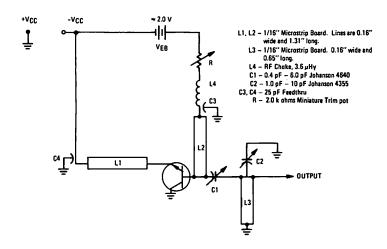
| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|----------------------|------|---------------------------------------|-----------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 5.0 mAdc, R _{BE} = 10 ohms) | V(BR)CER | 55 | - | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 0.1 mAdc, I _E = 0) | V(BR)CBO | 55 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 0.1 mAdc, IC = 0) | V(BR)EBO | 3.0 | _ | | Vdc |
| Collector Cutoff Current (VCE = 15 Vdc, IB = 0) | ICEO | _ | _ | 20 | μAdc |
| Collector Cutoff Current (VCE = 50 Vdc, VBE = 0) (VCE = 15 Vdc, VBE = 0, TC = 150°C) | ICES | | | 1.0 10 | μAdc mAdc |
| ON CHARACTERISTICS | | | · · · · · · · · · · · · · · · · · · · | | |
| Collector-Emitter Saturation Voltage (I _C = 100 mAdc, I _B = 10 mAdc) | V _{CE(sat)} | _ | _ | 0.5 | Vdc |
| SMALL SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 15 Vdc, f = 200 MHz) | fτ | 1200 | _ | _ | MHz |
| Output Capacitance (VCB = 30 Vdc, IE = 0, f = 1.0 MHz) | Cobo | _ | 1.3 | 3.0 | pF |
| FUNCTIONAL TEST | | | | | |
| Common-Emitter Amplifier Power Gain (Figure 1) (Pout = 1.0 W, VCC = 28 Vdc, IC = 102 mAdc, f = 1.0 GHz) | GPE | 5.0 | _ | _ | dB |
| Power Output (Figure 1) (Pin = 316 mW, VCE = 28 Vdc, f = 1.0 Ghz) | Pout | 1.0 | _ | _ | Watt |
| Collector Efficiency (Figure 1) (Pin = 316 mW, VCE = 28 Vdc, f = 1.0 GHz) | η | 35 | _ | - | % |
| Power Output (Oscillator) (Figure 2) (VCE = 20 Vdc, VEB = 1.5 Vdc, f = 1.68 GHz) (Minimum Efficiency = 15%) | Pout | - | 0.3 | - | Watt |

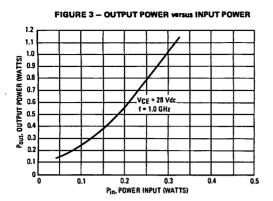
FIGURE 1 – 1 GHz RF AMPLIFIER OUTPUT POWER TEST CIRCUIT

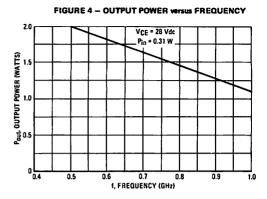


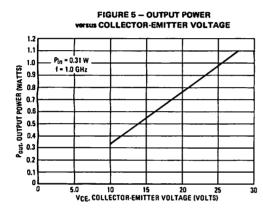
Note: Impedance measurements are made at transistor socket pins.

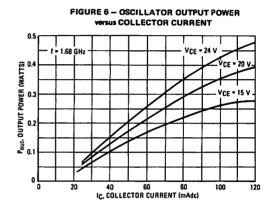
FIGURE 2 – 1.68 GHz RF OSCILLATOR OUTPUT POWER TEST CIRCUIT

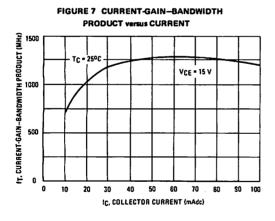


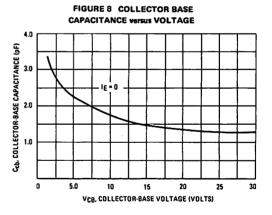












JAN, JTX, JTXV AVAILABLE CASE 79-02, STYLE 1 TO-39 (TO-205AD)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MAXIMUM RATINGS | | | |
|--|------------------|-------------|---------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Base Voltage | VCBO | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Base Current | ΙΒ | 400 | mAdc |
| Collector Current — Continuous | lc | 400 | mAdc |
| Total Device Dissipation @ T _C = 75°C(1) Derate above 25°C | PD | 2.5 20 | Watt mW/°C |
| Storage Temperature | T _{stg} | -65 to +200 | င |

⁽¹⁾ Total Device Dissipation at TA = 25°C is 1.0 Watt.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|-----------------|-----------|--------|------------|--------------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(2) (I _C = 5.0 mAdc, R _{BE} = 10 Ω) | V(BR)CER | 40 | 1 | - | Vdc |
| Collector-Emitter Sustaining Voltage (I _C = 5.0 mAdc, I _B = 0) | V(BR)CEO | 20 | - | _ | Vdc |
| Collector Cutoff Current (VCE = 15 Vdc, IB = 0) | ICEO | 1 | ı | 20 | μAdc |
| Collector Cutoff Current (V _{CE} = 15 Vdc, V _{BE} = -1.5 V, T _C = 150°C) (V _{CE} = 35 Vdc, V _{BE} = -1.5 V) | ICEX | _ | - - | 5.0 5.0 | mAdc mAdc |
| Emitter Cutoff Current (VBE = 3.0 Vdc, IC = 0) | IEBO | _ | | 100 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gein (I _C = 360 mAdc, V _{CE} = 5.0 Vdc) (I _C = 50 mAdc, V _{CE} = 15 Vdc) | hFE | 5.0 40 | = | 120 | |
| SMALL SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 15 Vdc, f = 200 MHz) | ÍΤ | 1200 | _ | _ | MHz |
| Collector-Base Capacitance (VCB = 15 Vdc, IE = 0, f = 1.0 MHz) | C _{cb} | _ | 1.8 | 3.5 | pF |
| Noise Figure (I _C = 10 mAdc, V _{CE} = 15 Vdc, f = 200 MHz) | NF | - | 3.0 | _ | dB |
| FUNCTIONAL TEST | | | | | |
| Common-Emitter Amplifier Voltage Gain (Figure 1) (IC = 50 mAdc, VCC = 15 Vdc, f = 50 to 216 MHz) | G _{ve} | 11 | _ | _ | dB |
| Power Input (Figure 2) (IC = 50 mAdc, V _{CC} = 15 Vdc, R _S = 50 ohms, P _{OUT} = 1.26 mW, f = 200 MHz) | Pin | _ | _ | 0.1 | mW |

⁽²⁾ Pulsed thru a 25 mH Inductor; 50% Duty Cycle.

FIGURE 1 – RF AMPLIFIER FOR VOLTAGE
GAIN TEST CIRCUIT

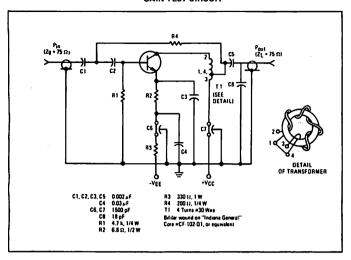
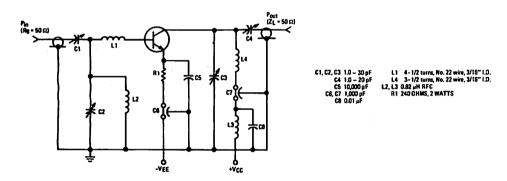
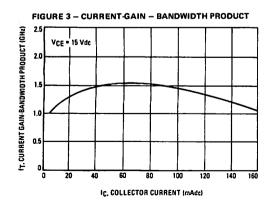
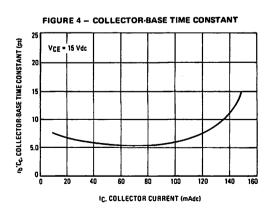
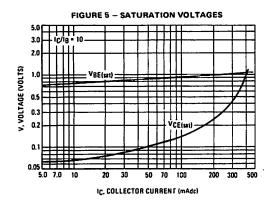


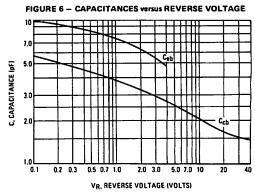
FIGURE 2 - 200 MHz TEST CIRCUIT

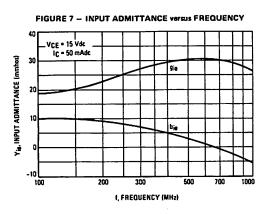


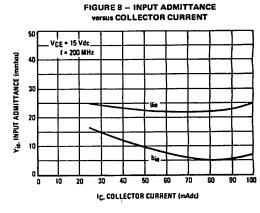


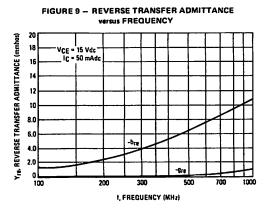












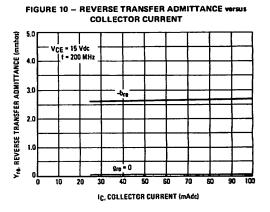


FIGURE 11 - FORWARD TRANSFER ADMITTANCE

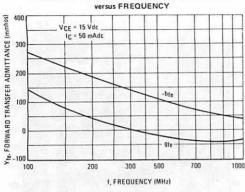


FIGURE 12 – FORWARD TRANSFER ADMITTANCE versus
COLLECTOR CURRENT

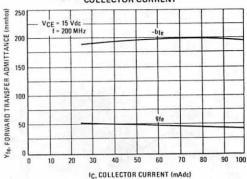


FIGURE 13 - OUTPUT ADMITTANCE versus FREQUENCY

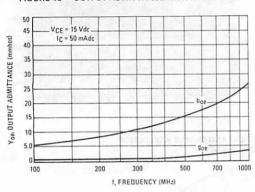


FIGURE 14 - OUTPUT ADMITTANCE versus COLLECTOR

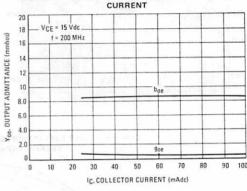


FIGURE 15 - INPUT REFLECTION COEFFICIENT versus FREQUENCY

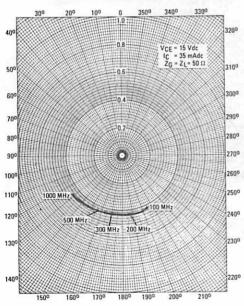


FIGURE 16 – OUTPUT REFLECTION COEFFICIENT versus

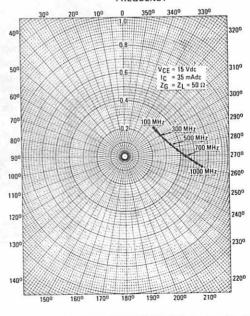


FIGURE 17 – REVERSE TRANSMISSION COEFFICIENT versus FREQUENCY

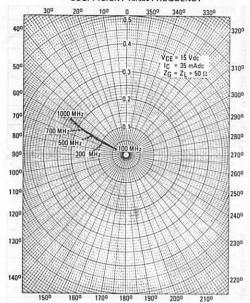


FIGURE 18 — FORWARD TRANSMISSION COEFFICIENT

Versus FREQUENCY

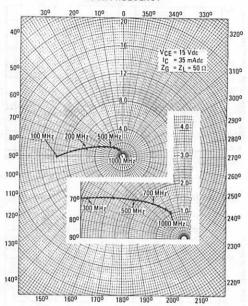
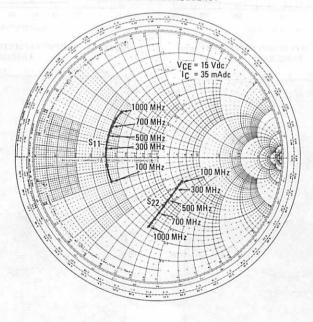


FIGURE 19 - INPUT REFLECTION COEFFICIENT AND OUTPUT REFLECTION
COEFFICIENT Versus FREQUENCY



CASE 79-02, STYLE 1 TO-39 (TO-205AD)

HIGH FREQUENCY TRANSISTOR

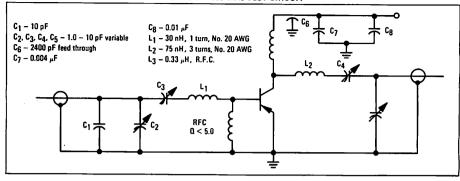
PNP SILICON

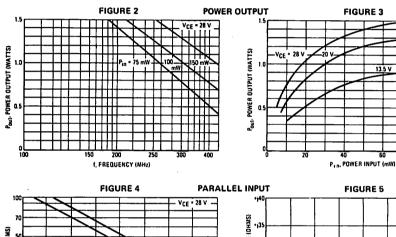
MAXIMUM RATINGS

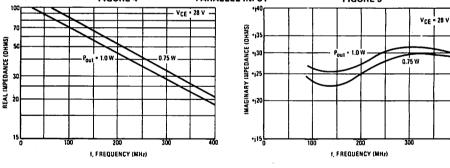
| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | V _{CBO} | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current | lc | 0.4 | Adc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

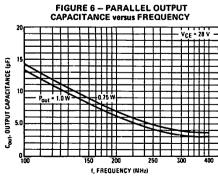
| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|------------------|-----|-------------|----------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Sustaining Voltage (I _C = 5.0 mAdc, I _B = 0) | VCEO(sus) | 40 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 0.1 mAdc, IC = 0) | V(BR)EBO | 4.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCE = 28 Vdc, IB = 0) | ICEO | - | | 20 | μAdc |
| Collector Cutoff Current (VCE = 60 Vdc, VBE = 0) | ICES | 1 | _ | 0.1 | mAdc |
| Collector Cutoff Current (VCB = 28 Vdc, IE = 0) | Ісво | 1 | - | 1.0 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 50 mAdc, VCE = 5.0 Vdc) | hFE | 10 | _ | _ | _ |
| SMALL SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (I _C = 50 mAdc, V _{CE} = 15 Vdc, f = 200 MHz) | ţţ | 500 | 900 | _ | MHz |
| Collector-Base Capacitance (VCB = 28 Vdc, I _E = 0, f = 0.1 to 1.0 MHz) | C _{cb} | _ | 2.5 | 4.0 | pF |
| FUNCTIONAL TEST | | | | | |
| Amplifier Power Gain (V _{CE} = 28 Vdc, P _{in} = 0.16 Watt, f = 400 MHz) (V _{CE} = 28 Vdc, P _{in} = 50 mW, f = 175 MHz) | G _{pe} | 8.0 | 8.8 14.5 | | dB |
| Power Output (VCE = 28 Vdc, P _{in} = 0.16 Watt, f = 400 MHz) (VCE = 28 Vdc, P _{in} = 50 mW, f = 175 MHz) | P _{out} | 1.0 | 1.2 1.4 | <u>-</u> | Watt |
| Collector Efficiency (VCE = 28 Vdc, Pin = 0.16 Watt, f = 400 MHz) | η | 45 | 55 | - | % |

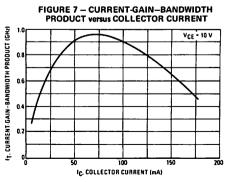
FIGURE 1 - 400-MHz TEST CIRCUIT











CASE 20-03, STYLE 10 TO-72 (TO-206AF)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

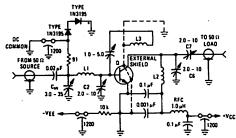
| Rating | Symbol | Value | Unit |
|---|------------------|-------------|-------------|
| Collector-Emitter Voltage Applicable 1.0 to 2.0 mAdc | VCEO | 12 | Vdc |
| Collector-Base Voltage | VCBO | 20 | Vdc |
| Emitter-Base Voltage | VEBO | 2.5 | Vdc |
| Collector Current | lc | 50 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 200 1.14 | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 300 1.71 | mW mW/°C |
| Storage Temperature | T _{stg} | -65 to +200 | °C |

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|--|-----------------------|----------|-------------|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Sustaining Voltage (I _C = 3.0 mAdc, I _B = 0) | V _{CEO(sus)} | 12 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 0.001 mAdc, I _E = 0) | V(BR)CBO | 20 | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 0.01 mAdc, I _C = 0) | V(BR)EBO | 2.5 | _ | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) (VCB = 15 Vdc, IE = 0, TA = 150°C) | ІСВО | <u>-</u> | 0.02 1.0 | μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 3.0 mAdc, V _{CE} = 1.0 Vdc) | hFE | 25 | 250 | |
| Collector-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | VCE(sat) | _ | 0.4 | Vdc |
| Base-Emitter Saturation Voltage (I _C = 10 mAdc, I _B = 1.0 mAdc) | V _{BE(sat)} | | 1.0 | Vdc |
| SMALL SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product(1) (I _C = 5.0 mAdc, V _{CE} = 6.0 Vdc, f = 100 MHz) | ÍΤ | 900 | 2000 | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, IE = 0, f = 0.1 to 1.0 MHz) | C _{cb} | _ | 1.0 | pF |
| Small Signal Current Gain (I _C = 2.0 mAdc, V _{CE} = 6.0 Vdc, f = 1.0 kHz) | h _{fe} | 25 | 300 | _ |
| Collector Base Time Constant (I _E = 2.0 mAdc, V _{CB} = 6.0 Vdc, f = 31.9 MHz) | rb'C _C | 3.0 | 14 | ps |
| Noise Figure (Figure 1) (I _C = 1.5 mAdc, V _{CE} = 6.0 Vdc, R _S = 50 ohms, f = 200 MHz) | NF | _ | 4.5 | dB |
| FUNCTIONAL TEST | | | | |
| Common-Emitter Amplifier Power Gain (Figure 1) (VCE = 6.0 Vdc, IC = 5.0 mAdc, f = 200 MHz) | G _{pe} | 15 | - | dB |
| Power Output (Figure 2) (V _{CB} = 10 Vdc, I _E = 12 mAdc, f≥500 MHz) | Pout | 20 | _ | mW |
| 1916 in defined as the francisco of which the Landson describer | | | - | |

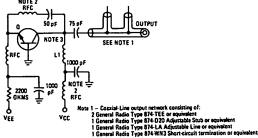
(1) fT is defined as the frequency at which |hfe| extrapolates to unity.

FIGURE 1 - 200 MHz AMPLIFIER POWER GAIN AND NOISE FIGURE CIRCUIT



- L1 1-3/4 Turns, #18 AWG, 0.5" L, 0.5" Diamete
- L2 2 Turns, #16 AWG, 0.5" L, 0.5" Diameter L3 2 Turns, #13 AWG, 0.25" L, 0.5" Diameter (Position 1/4" from L2)

FIGURE 2 - 500 MHz OSCILLATOR CIRCUIT



Note 2 - RFC = 0.2 µH Chmits #2-460 or equivalent Note 3 - Lead Number 4 (case) floating

L1 - 2 turns #16 AWG wire, 3/8 inch CD, 1-1/4 inch long

FIGURE 3 - NOISE FIGURE versus FREQUENCY

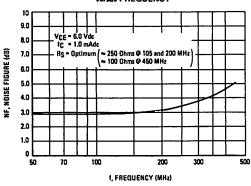


FIGURE 4 - NOISE FIGURE versus SOURCE RESISTANCE and COLLECTOR CURRENT

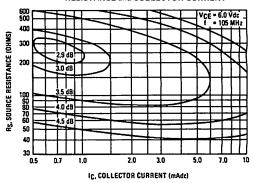
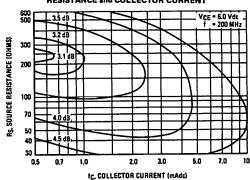
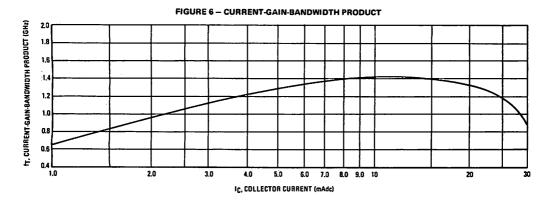
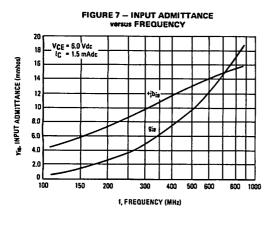
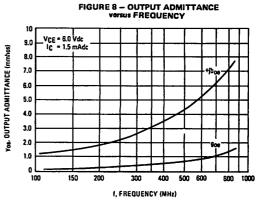


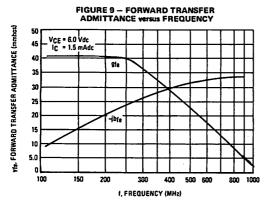
FIGURE 5 - NOISE FIGURE versus SOURCE RESISTANCE and COLLECTOR CURRENT











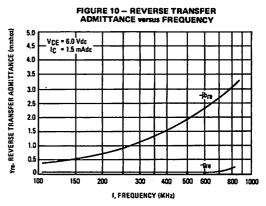


FIGURE 11- S11, INPUT REFLECTION COEFFICIENT FIGURE 12-S22, OUTPUT REFLECTION COEFFICIENT

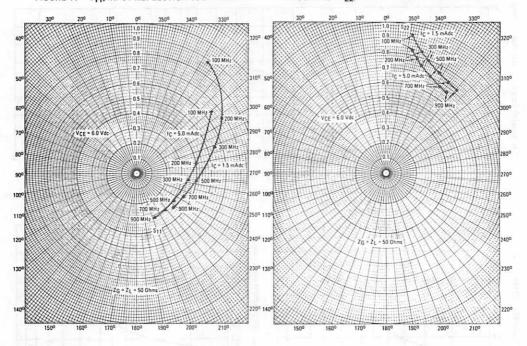


FIGURE 13 - S₁₂, REVERSE TRANSMISSION COEFFICIENT

FIGURE 14 - S21, FORWARD TRANSMISSION COEFFICIENT

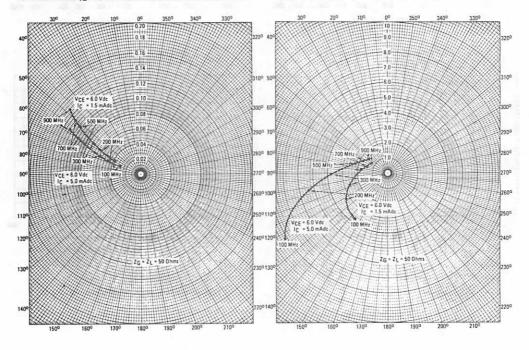
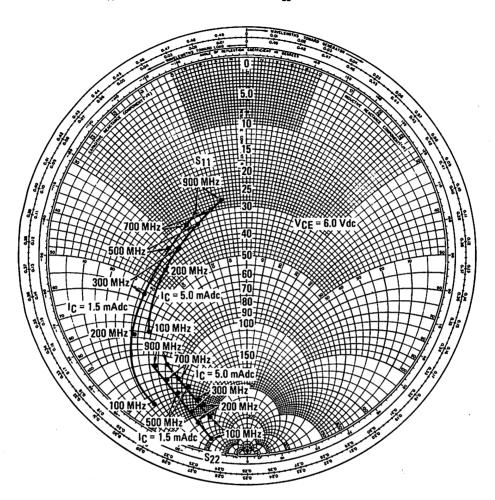


FIGURE 15-S₁₁, INPUT REFLECTION COEFFICIENT AND S₂₂, OUTPUT REFLECTION COEFFICIENT



JAN, JTX, JTXV AVAILABLE CASE 79-02, STYLE 1 TO-39 (TO-205AD)

HIGH FREQUENCY TRANSISTOR

PNP SILICON

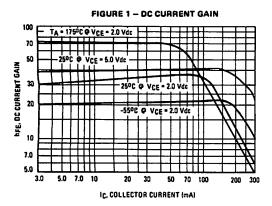
MAXIMUM RATINGS

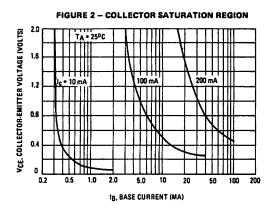
| MAXIMUM RATINGS | | | | | | |
|---|----------------------|-------------|----------------|--|--|--|
| Rating | Symbol | Value | Unit | | | |
| Collector-Emitter Voltage | VCEO | 30 | Vdc | | | |
| Collector-Base Voltage | V _{CBO} | 30 | Vdc | | | |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc | | | |
| Collector Current — Continuous | lc | 500 | mAdc | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.71 | Watt mW/°C | | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | Watts mW/°C | | | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | ဇ | | | |

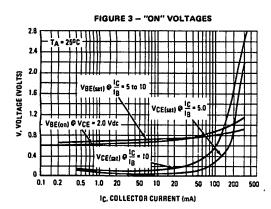
ELECTRICAL CHARACTERISTICS ($T_A = 25^{\circ}C$ unless otherwise noted.)

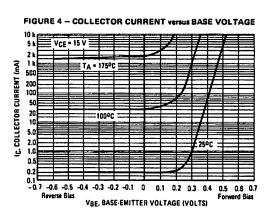
| | Characteristic | Symbol | Min | Тур | Max | Unit |
|---|---|----------------------|----------------|----------------|---------------|------|
| OFF CHARACTERISTICS | | _ | | | | |
| Collector-Emitter Breakdo | | V(BR)CEO | 30 | _ | _ | Vdc |
| Collector-Base Breakdown (IC = 10 μAdc, IE = 0) | n Voltage | V(BR)CBO | 30 | _ | _ | Vdc |
| Emitter-Base Breakdown (IE = 100 μAdc, IC = 0 | | V(BR)EBO | 3.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 20 Vdc, IE = 0) |) | СВО | - | _ | 50 | nAdc |
| Emitter Cutoff Current (VEB = 2.0 Vdc, I _C = 0 |) | ^I EBO | ı | _ | 0.5 | μAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain(1) (IC = 40 mAdc, VCE = (IC = 100 mAdc, VCE = (IC = 300 mAdc, VCE = | = 2.0 Vdc) | hFE | 20 25 15 | 40 40 22 | _ 100 _ | - |
| Collector-Emitter Saturati | • | V _{CE(sat)} | _ | 0.6 | 0.8 | Vdc |
| Base-Emitter On Voltage(| | V _{BE(on)} | _ | 0.84 | 1.8 | Vdc |
| SMALL SIGNAL CHARAC | CTERISTICS | | | | | |
| Current-Gain — Bandwid (IC = 40 mAdc, VCE = (IC = 100 mAdc, VCE = | | fT | 1000 1300 | 1300 1500 | _ | MHz |
| Collector-Base Capacitane (VCB = 15 Vdc, IE = 0 | | C _{cb} | | 2.5 | 5.0 | pF |
| Emitter-Base Capacitance (VEB = 0.5 Vdc, I _C = 0 | | C _{eb} | _ | 18 | 35 | ρF |
| Collector Base Time Con- | stant 10 Vdc, f = 63.6 MHz) | rb'C _C | _ | 8.0 | - | ps |
| SWITCHING CHARACTE | RISTICS (FIGURE 10) | | | | | |
| Turn-On Delay Time | (V _{CC} = 31.4 Vdc, I _C = 150 mAdc, R _C = 160 Ohms, R _E = 26.6 Ohms) | ^t d | | 1.0 | _ | ns |
| Rise Time | | tr | | 2.1 | | ns |
| Fall Time | | t _f | - | 1.8 | _ | ns |

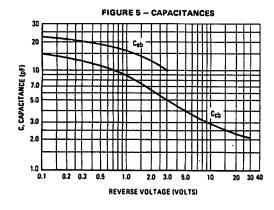
(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.











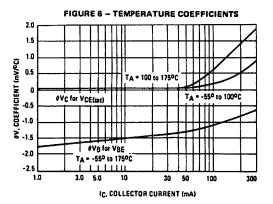


FIGURE 7 - CURRENT-GAIN-BANDWIDTH PRODUCT

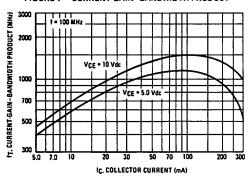


FIGURE 8 - COLLECTOR-BASE TIME CONSTANT

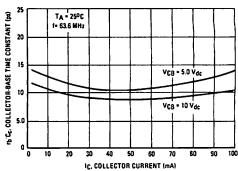


FIGURE 9 - SWITCHING TIMES

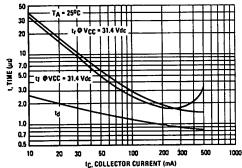
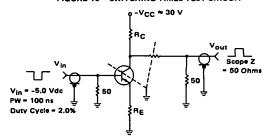


FIGURE 10 - SWITCHING TIMES TEST CIRCUIT



| IC mA | R _C Ohms | R _E Ohms | VCC Volts |
|----------|------------------------|------------------------|--------------|
| 50 | 526 | 80 | 34.4 |
| 150 | 160 | 26.6 | 31.4 |
| 300 | 78 | 13.3 | 30.6 |
| 500 | 46.5 | 8.0 | 30.3 |

2N5835 2N5836 2N5837

MAXIMUM RATINGS

| Rating | Symbol | 2N5835 | 2N5836 | 2N5837 | Unit |
|--|------------------|-------------|--------------|--------------|----------------|
| Collector-Emitter Voltage | VCEO | 10 | 10 | 5.0 | Vdc |
| Collector-Base Voltage | V _{CBO} | 15 | 15 | 10 | Vdc |
| Emitter-Base Voltage | VEBO | 3.5 | 3.5 | 3.5 | Vdc |
| Collector Current — Continuous | l _C | 15 | 200 | 300 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 200 1.14 | _ | _ | mW mW/°C |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | _ | 2.0 11.43 | 2.0 11.43 | Watts mW/°C |
| Storage Temperature | T _{stg} | _ | 00 | °C | |

2N5835 CASE 20-03, STYLE 10 TO-72 (TO-206AF)

2N5836, 2N5837 CASE 26-03, STYLE 1 TO-46 (TO-206AB)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

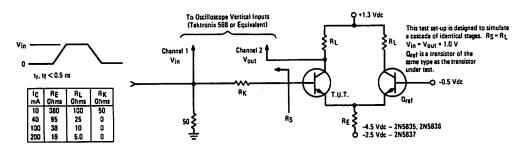
| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|----------------------------|---------------------|----------------|-------------------|-------------------|------|
| OFF CHARACTERISTICS | | • | - | | | |
| Collector-Base Breakdown Voltage (IC = 10 µAdc, IE = 0) | 2N5835 | V(BR)CBO | 15 | - | _ | Vdc |
| (IC = 100 µAdc, IE = 0) | 2N5836 2N5837 | | 15 10 | = | _ |] |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | | V(BR)EBO | 3.5 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 7.5 Vdc, IE = 0) (VCB = 10 Vdc, IE = 0) (VCB = 5.0 Vdc, IE = 0) | 2N5835 2N5836 2N5837 | ІСВО | - - - | = | 0.01 10 10 | μAdc |
| Emitter Cutoff Current (VEB = 3.0 Vdc, IC = 0) | · · · · · · | IEBO | | _ | 100 | μAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain (IC = 10 mAdc, VCE = 6.0 Vdc) (IC = 50 mAdc, VCE = 6.0 Vdc) (IC = 100 mAdc, VCE = 3.0 Vdc) | 2N5835 2N5836 2N5837 | hFE | 25 25 25 | = | = | - |
| Base-Emitter On Voltage (I _C = 10 mAdc, V _{CE} = 6.0 Vdc) (I _C = 50 mAdc, V _{CE} = 6.0 Vdc) (I _C = 100 mAdc, V _{CE} = 3.0 Vdc) | 2N5835 2N5836 2N5837 | V _{BE(on)} | <u>-</u> | <u>-</u> | 0.9 0.9 0.9 | Vdc |
| SMALL SIGNAL CHARACTERISTICS Current-Gain — Bandwidth Product(1) (IC = 10 mAdc, VCE = 6.0 Vdc, f = 200 MHz) (IC = 50 mAdc, VCE = 6.0 Vdc, f = 200 MHz) | 2N5835 | fT | 2.5 | _ | _ | GHz |
| (IC = 100 mAdc, VCE = 8.0 Vdc, f = 200 MHz) | 2N5836 2N5837 | | 2.0 1.7 | = | = | |
| Collector-Base Capacitance (VCB = 10 Vdc, IE = 0, f = 0.1 to 1.0 MHz) | 2N5835 2N5836 | C _{cb} | = | = | 0.8 3.5 | pF |
| $(V_{CB} = 5.0 \text{ Vdc}, I_{E} = 0, f = 0.1 \text{ to } 1.0 \text{ MHz})$ | 2N5837 | | _ | - | 5.0 | |
| Collector Base Time Constant(2) (I _C = 10 mAdc, V _{CE} = 6.0 Vdc, f = 63.6 MHz) (I _C = 50 mAdc, V _{CE} = 6.0 Vdc, f = 63.6 MHz) (I _C = 100 mAdc, V _{CE} = 3.0 Vdc, f = 63.6 MHz) | 2N5835 2N5836 2N5837 | rb'C _C | = | 5.0 6.0 6.0 | 111 | ps |

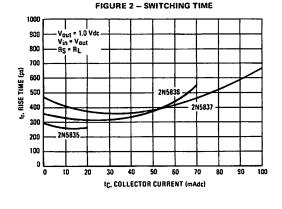
2N5835 • 2N5836 • 2N5837

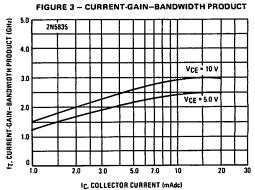
| Characteristic | | Symbol | Min | Тур | Max | Unit |
|------------------------------|--------|--------|----------|-----|----------|------|
| SWITCHING CHARACTERISTICS(2) | | | | | | |
| Rise Time (Figure 1) | | tr | | ĺ | | ns |
| (I _C = 10 mAdc) | 2N5835 | | – | 250 | _ | |
| (IC = 40 mAdc) | 2N5836 | | l — | 320 | - | 1 |
| (IC = 100 mAdc) | 2N5837 | | | 650 | <u> </u> | |

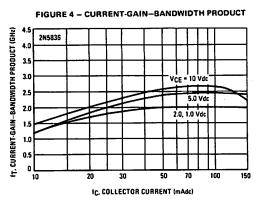
⁽¹⁾ fT is defined as the frequency at which |hfe| extrapolates to unity.

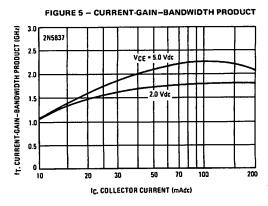
FIGURE 1 - SWITCHING TIME TEST CIRCUIT



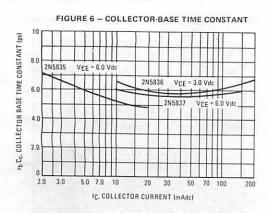


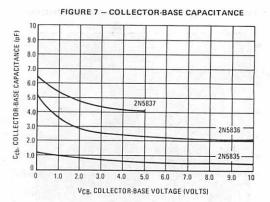






⁽²⁾ Typical values shown in addition to JEDEC Registered Data.





2N5835 SCATTERING PARAMETERS (IC = 5.0 mAdc, V_{CE} = 6.0 Vdc, Z_{G} = Z_{L} = 50 Ohms)

FIGURE 8 - S₁₁, INPUT REFLECTION COEFFICIENT

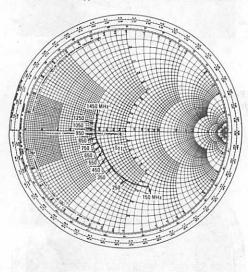


FIGURE 9 - S22, OUTPUT REFLECTION COEFFICIENT

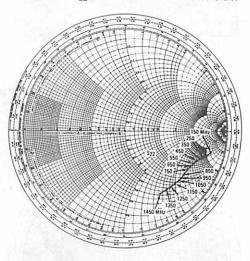


FIGURE 10 - S12, REVERSE TRANSMISSION COEFFICIENT

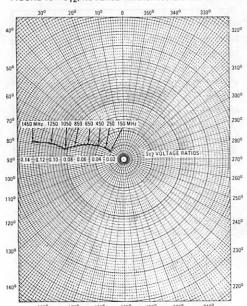
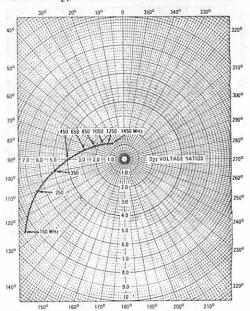


FIGURE 11 - S21, FORWARD TRANSMISSION COEFFICIENT



2N5836 SCATTERING PARAMETERS (IC = 100 mAdc, V_{CE} = 10 Vdc, Z_G = Z_L = 50 Ohms)

FIGURE 12 - S₁₁, INPUT REFLECTION COEFFICIENT

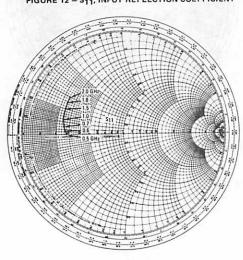


FIGURE 13 - S22, OUTPUT REFLECTION COEFFICIENT

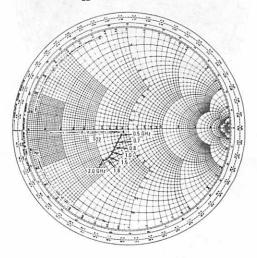


FIGURE 14 - S₁₂, REVERSE TRANSMISSION COEFFICIENT

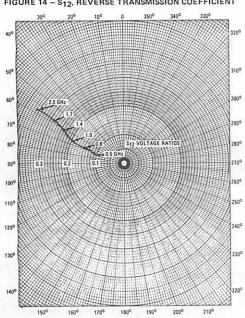
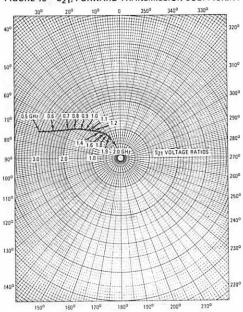


FIGURE 15 - S21, FORWARD TRANSMISSION COEFFICIENT



2N5837 SCATTERING PARAMETERS

 $(I_C = 100 \text{ mAdc}, V_{CE} = 3.0 \text{ Vdc}, Z_G = Z_L = 50 \text{ Ohms})$

FIGURE 16 - S₁₁, INPUT REFLECTION COEFFICIENT

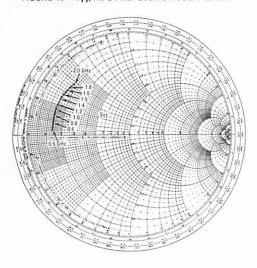


FIGURE 17 - S22, OUTPUT REFLECTION COEFFICIENT

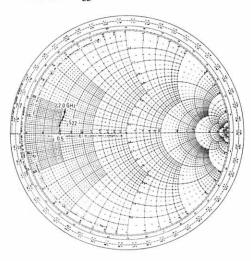


FIGURE 18 - S12, REVERSE TRANSMISSION COEFFICIENT

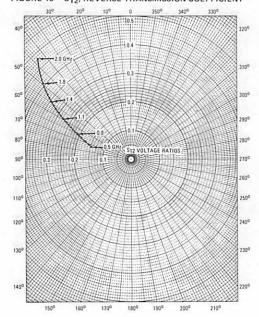
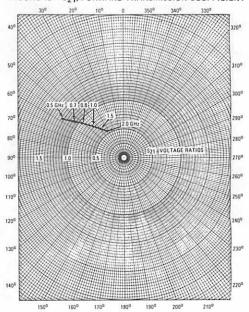


FIGURE 19 - S21, FORWARD TRANSMISSION COEFFICIENT



CASE 79-02, STYLE 1 TO-39 (TO-205AD)

HIGH FREQUENCY TRANSISTOR

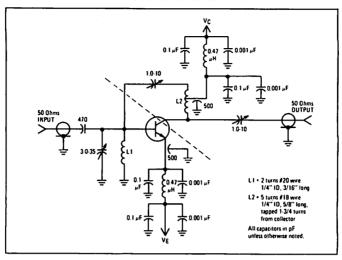
NPN SILICON

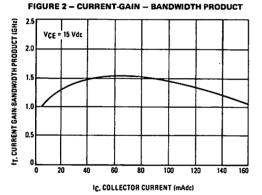
MAXIMUM RATINGS

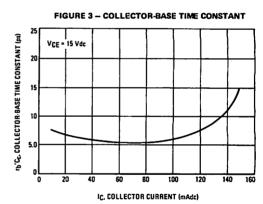
| Symbol | Value | Unit |
|----------------------|----------------------|---|
| VCEO | 30 | Vdc |
| V _{CBO} | 40 | Vdc |
| VEBO | 3.5 | Vdc |
| lc | 400 | mAdc |
| PD | 1.0 5.7 | Watt mW/°C |
| PD | 3.5 0.02 | Watts mW/°C |
| TJ, T _{stg} | -65 to +200 | •° |
| | VCEO VCBO VEBO IC PD | VCEO 30 VCBO 40 VEBO 3.5 IC 400 PD 1.0 5.7 PD 3.5 0.02 |

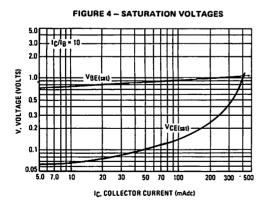
| ELECTRICAL CHARACTERISTICS (T _A = 25°C unless otherwise noted.) | | | | | |
|---|----------------------|----------------------|----------------------|--------------|------|
| Characteristic | Symbol | Min | Тур | Max | Unit |
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 5.0 mAdc, IB = 0) | V(BR)CEO | 30 | | | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μAdc, IE = 0) | V(BR)CBO | 40 | _ | | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 µAdc, IC = 0) | V(BR)EBO | 3.5 | _ | | Vdc |
| Collector Cutoff Current (VCE = 20 Vdc, lg = 0) | 1CEO | | - | 50 | μAdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) | ICBO | I | | 10 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 50 mAdc, VCE = 15 Vdc) | hFE | 25 | _ | 300 | _ |
| Collector-Emitter Saturation Voltage (IC = 100 mAdc, IB = 10 mAdc) | V _{CE(sat)} | | 0.15 | 0.2 | Vdc |
| Base-Emitter Saturation Voltage (IC = 100 mAdc, IB = 10 mAdc) | V _{BE(sat)} | ı | 0.88 | 1.0 | Vdc |
| SMALL SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 25 mAdc, VCE = 15 Vdc, f = 200 MHz) (IC = 50 mAdc, VCE = 15 Vdc, f = 200 MHz) (IC = 100 mAdc, VCE = 15 Vdc, f = 200 MHz) | fτ | 1000 1200 1000 | 1350 1550 1425 | 2400 | MHz |
| Collector-Base Capacitance (VCB = 30 Vdc, I _E = 0, f = 100 kHz) | C _{cb} | 1.0 | 1.6 | 2.5 | pF |
| Emitter-Base Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 100 kHz) | C _{eb} | _ | 8.4 | 15 | рF |
| Small Signal Current Gain (IC = 50 mAdc, VCE = 15 Vdc, f = 1.0 kHz) | h _{fe} | 25 | | 350 | - |
| Collector Base Time Constant (IE = 50 mAdc, VCB = 15 Vdc, f = 31.8 MHz) | rb'C ^C | 2.0 | 5.5 | 20 | ps |
| Noise Figure (IC = 30 mAdc, VCE = 15 Vdc, f = 200 MHz) (Figure 1) (IC = 35 mAdc, VCE = 15 Vdc, f = 200 MHz) (Figure 6) | NF | | 3.4 6.8 | 8.0 | d₿ |
| FUNCTIONAL TEST | | _ | | | |
| Common-Emitter Amplifier Power Gain (IC = 10 mAdc, VCE = 15 Vdc, f = 200 MHz) (Figure 1) (IC = 50 mAdc, VCE = 15 Vdc, f = 250 MHz) (Figure 6) | G _{pe} | 7.0 | 11.4 7.6 | _ | d₿ |
| Intermodulation Distortion (IC = 50 mAde, V _{CE} = 15 Vdc, V _{Out} = +50 dBmV) | IM | _ | _ | -50 | ďΒ |
| Cross Modulation Distortion (IC = 50 mAdc, V _{CE} = 15 Vdc, V _{Out} = +40 dBmV) (IC = 50 mAdc, V _{CE} = 15 Vdc, V _{Out} = +50 dBmV) | ХМ | = | - 67 - 45 | -42 | dB |

FIGURE 1 - NARROW-BAND TEST CIRCUIT









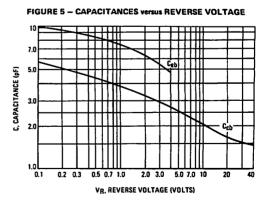


FIGURE 6 - BROADBAND TEST CIRCUIT

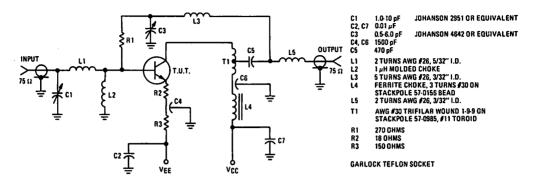


FIGURE 7 — CROSS-MODULATION DISTORTION versus
COLLECTOR CURRENT

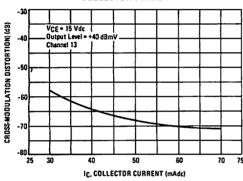


FIGURE 8 - CROSS-MODULATION
DISTORTION Versus OUTPUT LEVEL

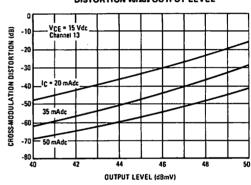


FIGURE 9 - NARROWBAND NOISE FIGURE versus
COLLECTOR CURRENT

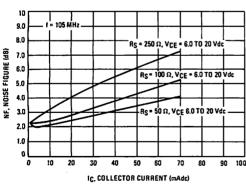


FIGURE 10 - NARROWBAND NOISE FIGURE versus
COLLECTOR CURRENT

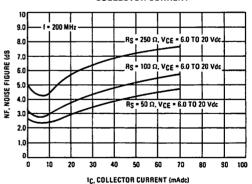


FIGURE 11 - BROADBAND NOISE FIGURE Versus
COLLECTOR CURRENT

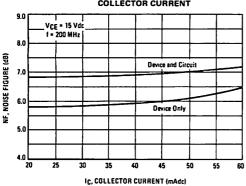


FIGURE 12 - NARROWBAND NOISE FIGURE versus FREQUENCY

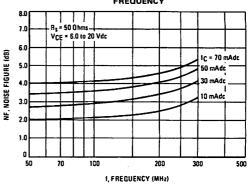


FIGURE 13 - INPUT ADMITTANCE versus FREQUENCY

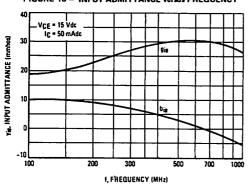


FIGURE 14 - INPUT ADMITTANCE versus COLLECTOR CURRENT

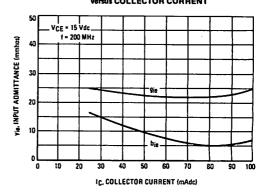


FIGURE 15 — REVERSE TRANSFER ADMITTANCE

VOTSUS FREQUENCY

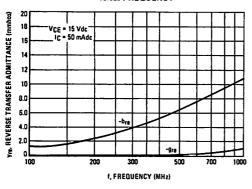


FIGURE 16 - REVERSE TRANSFER ADMITTANCE versus
COLLECTOR CURRENT

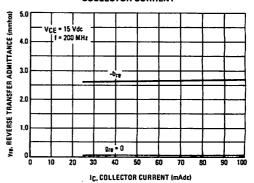


FIGURE 17 - FORWARD TRANSFER ADMITTANCE versus FREQUENCY

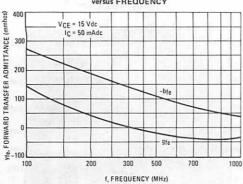


FIGURE 18 - FORWARD TRANSFER ADMITTANCE versus
COLLECTOR CURRENT

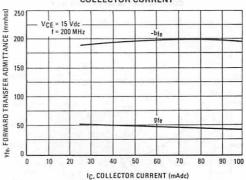


FIGURE 19 - OUTPUT ADMITTANCE versus FREQUENCY

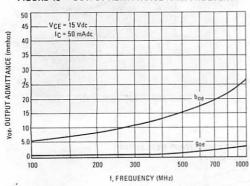


FIGURE 20 — OUTPUT ADMITTANCE versus COLLECTOR CURRENT

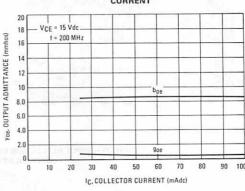


FIGURE 21 – INPUT REFLECTION COEFFICIENT versus FREQUENCY

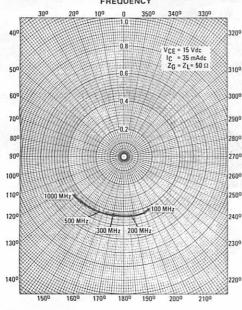


FIGURE 22 – OUTPUT REFLECTION COEFFICIENT versus FREQUENCY

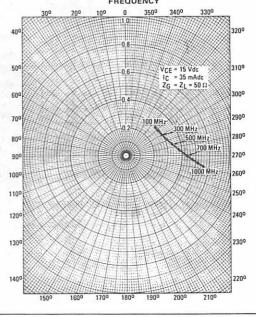


FIGURE 23 – REVERSE TRANSMISSION COEFFICIENT versus FREQUENCY

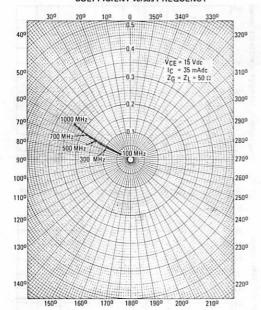


FIGURE 24 - FORWARD TRANSMISSION COEFFICIENT VOISUS FREQUENCY

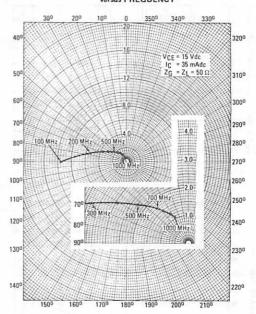
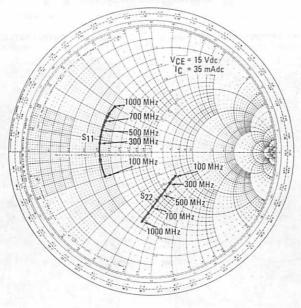


FIGURE 25 – INPUT REFLECTION COEFFICIENT AND OUTPUT REFLECTION COEFFICIENT Versus FREQUENCY



CASE 244A-01, STYLE 1 TO-117 (TO-232AA)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

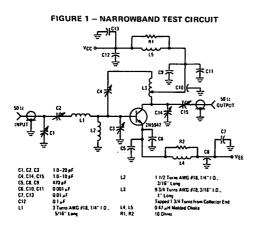
MAXIMUM RATINGS

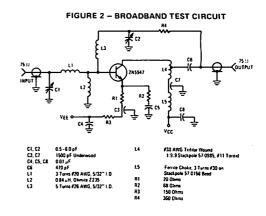
| Rating | Symbol | Value | Unit |
|--|------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 30 | Vdc |
| Collector-Base Voltage | V _{CBO} | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 3.5 | Vdc |
| Collector Current — Continuous | lc | 400 | mAdc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | Watts mW/°C |
| Storage Temperature | T _{stg} | -65 to +200 | °C |

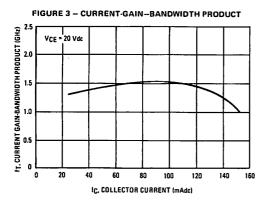
ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

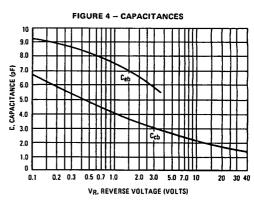
| Characteristic | Symbol | Min ' | Тур | Max | Unit |
|---|----------------------|---------------------------------------|-------------------|-------------|------|
| OFF CHARACTERISTICS | | _ | | | |
| Collector-Emitter Breakdown Voltage (IC = 20 mAdc, IB = 0) | V(BR)CEO | 30 | | | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μAdc, IE = 0) | V(BR)CBO | 40 | _ | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 μAdc, I _C = 0) | V(BR)EBO | 3.5 | _ | - | Vdc |
| Collector Cutoff Current (VCE = 28 Vdc, tg = 0) | ICEO | | - | 100 | μAdc |
| Collector Cutoff Current (VCB = 20 Vdc, !E = 0) | Ісво | _ | _ | 10 | μAdc |
| Emitter Cutoff Current (VBE = 3.5 Vdc, IC = 0) | IEBO | - | _ | 100 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 75 mAdc, V _{CE} = 20 Vdc) | hFE | 25 | - | 250 | - |
| Collector-Emitter Saturation Voltage (IC = 200 mAdc, IB = 20 mAdc) | V _{CE(sat)} | _ | 0.2 | 0.35 | Vdc |
| Base-Emitter Saturation Voltage (IC = 200 mAdc, IB = 20 mAdc) | V _{BE(sat)} | - | 1.0 | 1.5 | Vdc |
| SMALL SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 75 mAdc, VCE = 20 Vdc, f = 200 MHz) | fτ | 1100 | 1500 | _ | MHz |
| Collector-Base Capacitance (V _{CB} = 30 Vdc, I _E = 0, f = 100 kHz) | C _{cb} | _ | 1.5 | 4.0 | pF |
| Emitter-Base Capacitance (VEB = 0.5 Vdc, IC = 0, f = 100 kHz) | C _{eb} | _ | 8.2 | 12 | pF |
| Small Signal Current Gain (I _C = 75 mAdc, V _{CE} = 20 Vdc, f = 1.0 kHz) | h _{fe} | 25 | _ | 300 | _ |
| Collector Base Time Constant (I _E = 75 mAdc, V _{CB} = 20 Vdc, f = 31.8 MHz) | rb'C _C | 2.0 | _ | 20 | ps |
| Noise Figure (I _C = 50 mAdc, V _{CE} = 20 Vdc, f = 200 MHz) (Figure 1) (I _C = 50 mAdc, V _{CE} = 20 Vdc, f = 200 MHz)(1) (Figure 2) (I _C = 75 mAdc, V _{CE} = 20 Vdc, f = 200 MHz)(1) (Figure 2) | NF | = | 3.8 7.2 7.8 | 8.5 | dB |
| FUNCTIONAL TEST | | · · · · · · · · · · · · · · · · · · · | · · · · · · · · · | | |
| Common-Emitter Amplifier Power Gain (Figure 2) (I _C = 75 mAdc, V _{CE} = 20 Vdc, f = 250 MHz) | G _{pe} | 10 | 11 | _ | dB |
| Intermodulation Distortion (Figure 2) (I _C = 75 mAdc, V _{CE} = 20 Vdc, V _{out} = +50 dBmV) | IM | _ | ~ 55 | -50 | dB |
| Cross Modulation Distortion (Figure 2) (I _C = 75 mAdc, V _{CE} = 20 Vdc, V _{Out} = +50 dBmV) | XM | _ | - 60 | - 57 | dB |

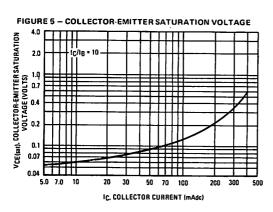
(1) Includes noise figure of post-amplifier and matching pad.

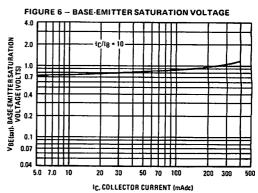


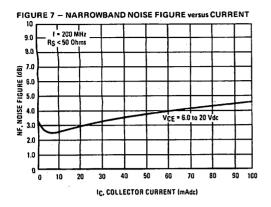


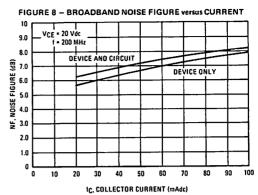


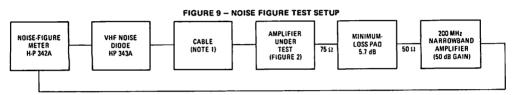








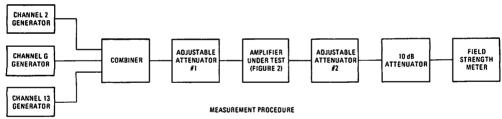




IOTE 1. RG-59 CABLE WITH ORIGINAL CENTER CONDUCTOR REPLACED WITH #30 WIRE. OVERALL LENGTH, INCLUDING BNC CONNECTORS, IS A QUARTER-WAVELENGTH AT 200 MHz (APPROX. 11 INCHES). USED TO MATCH IMPEDANCE OF NOISE DIODE TO AMPLIFIER UNDER TEST.

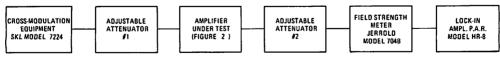
THE NOISE FIGURE OF THE POST-AMPLIFIERS AND MINIMUM LOSS PAD IS 8.4 dB.

FIGURE 10 - INTERMODULATION DISTORTION TEST SETUP



- 1. ADJUST CHANNEL 2 GENERATOR FOR RATED OUTPUT FROM TEST AMPLIFIER (CHANNELS G & 13 OFF).
- 2. REPEAT FOR CHANNEL G (2 & 13 OFF) AND CHANNEL 13 (2 & G OFF). NOTE FOR REFERENCE THE FIELD STRENGTH METER READING FOR CHANNEL 13 (2 & G OFF).
- 3. TURN CHANNEL 13 OFF AND DRIVE THE TEST AMPLIFIER WITH CHANNELS 2.8.G. MEASURE THE LEVEL OF INTERMODULATION DISTORTION AT CHANNEL 13 RELATIVE TO THE REFERENCE LEVEL IN STEP 2.

FIGURE 11 - CROSS MODULATION DISTORTION TEST SETUP



MEASUREMENT PROCEDURE

- 1. ADJUST THE CROSSMODULATION EQUIPMENT FOR +50 dBmV OUTPUT FROM EACH CHANNEL.
- 2. ADJUST ATTENUATOR #1 FOR THE DESIRED OUTPUT LEVEL FROM THE TEST AMPLIFIER. ADJUST ATTENUATOR #2 TO MAINTAIN THE FIELD STRENGTH METER INPUT AT +10 dBmV.
- 3. WITH THE FIELD STRENGTH METER SELECT CHANNEL 13. USING THE WAVE ANALYZER MEASURE THE LEVEL OF THE MODULATION ON CHANNEL 13 DUE TO CROSS-MODULATION OF CHANNELS 2-12.

FIGURE 12 – CROSS MODULATION DISTORTION
Versus OUTPUT LEVEL

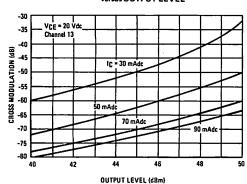
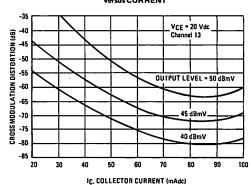


FIGURE 13 – CROSS MODULATION DISTORTION Versus CUR RENT



CASE 79-02, STYLE 1 TO-39 (TO-205AD)

HIGH FREQUENCY TRANSISTOR

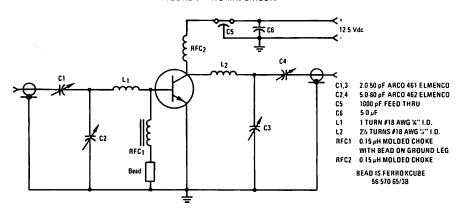
NPN SILICON

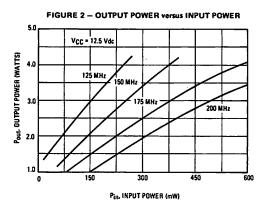
MAXIMUM RATINGS

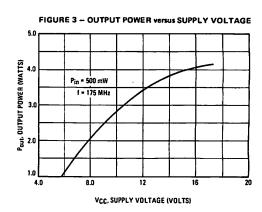
| Rating | Symbol | Value | Unit |
|---|--------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 18 | Vdc |
| Collector-Base Voltage | VCBO | 36 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | lc · | 1.0 | Adc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.5 | Watts mW/°C |
| Storage Temperature | Teta | -65 to +200 | °C |

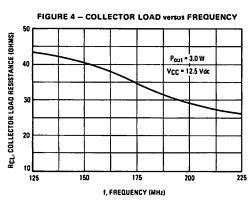
| Characteristic | Symbol | Min · | Тур | Max | Unit |
|---|------------------|-------|-----|------|------|
| OFF CHARACTERISTICS | | | | • | |
| Collector-Emitter Breakdown Voltage (IC = 10 mAdc, IB = 0) | V(BR)CEO | 18 | - | _ | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 5.0 mAdc, VBE = 0) | V(BR)CES | 36 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 1.0 mAdc, I _C = 0) | V(BR)EBO | 4.0 | _ | - | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, Ig = 0) | СВО | | - | 0.25 | mAdc |
| Collector Cutoff Current (VCE = 15 Vdc, VBE = 0, TC = 55°C) | ICES | - | _ | 5.0 | mAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 250 mAdc, V _{CE} = 5.0 Vdc) | hFE | 5.0 | _ | _ | _ |
| SMALL SIGNAL CHARACTERISTICS | | | | | |
| Output Capacitance (V _{CB} = 12.5 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | _ | 15 | 20 | ρF |
| FUNCTIONAL TEST (FIGURE 1) | | | | | |
| Common-Emitter Amplifier Power Gain (Pout = 3.0 W, VCC = 12.5 Vdc, f = 175 MHz) | GPE | 7.8 | - | _ | dB |
| Collector Efficiency (Pout = 3.0 W, V _{CC} = 12.5 Vdc, f = 175 MHz) | η | 50 | | | % |

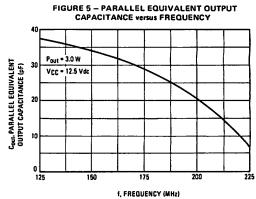
FIGURE 1 - 175 MHz CIRCUIT

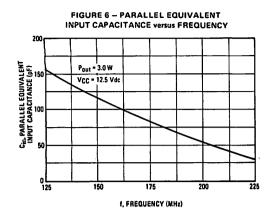


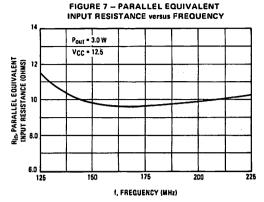












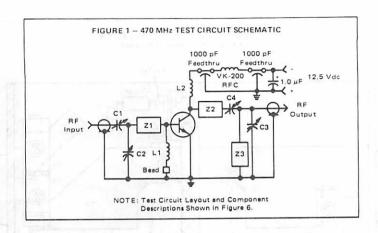
CASE 249-05, STYLE 1
UHF AMPLIFIER TRANSISTOR

NPN SILICON

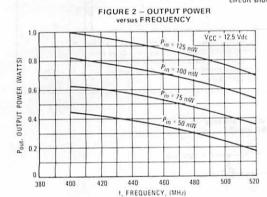
MAXIMUM RATINGS

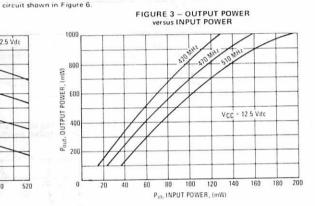
| WAXIIION RATINGS | | | |
|---|------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 16 | Vdc |
| Collector-Base Voltage | VCBO | 36 | Vdc |
| Emitter-Base Voltage | V _{EBO} | 4.0 | Vdc |
| Collector Current — Continuous | lc | 0.4 | Adc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.0 11.4 | Watts mW/°C |
| Storage Temperature | T _{sta} | -65 to +200 | °C |

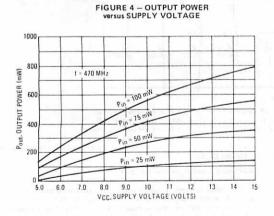
| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|----------------|------------------|-----|-----|-----|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 5.0 mAdc, IB = 0) | | V(BR)CEO | 16 | _ | _ | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 5.0 mAdc, VBE = 0) | | V(BR)CES | 36 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (Ig = 1.0 mAdc, IC = 0) | | V(BR)EBO | 4.0 | - | _ | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) | | ICBO | _ | _ | 0.5 | mAdc |
| Collector Cutoff Current (VCE = 15 Vdc, VBE = 0, TA = 125°C) | | ICES | _ | _ | 5.0 | mAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain (IC = 50 mAdc, VCE = 5.0 Vdc) | | ptE | 20 | 80 | 200 | - |
| SMALL SIGNAL CHARACTERISTICS | | | | | | |
| Output Capacitance (VCB = 12.5 Vdc, IE = 0, f = 1.0 MHz) | | C _{obo} | ı | 6.0 | 8.0 | pF |
| FUNCTIONAL TEST | - | | | | | |
| Common-Emitter Amplifier Power Gain (Pout = 0.5 W, VCC = 12.5 Vdc, f = 470 MHz) | (Figures 1, 6) | GPE | 7.0 | 9.0 | | dB |
| Collector Efficiency (Pout = 0.5 W, V _{CC} = 12.5 Vdc, f = 470 MHz) | (Figures 1, 6) | η | 60 | 70 | _ | % |

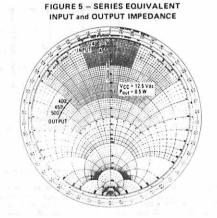


Typical Output Power curves were measured in









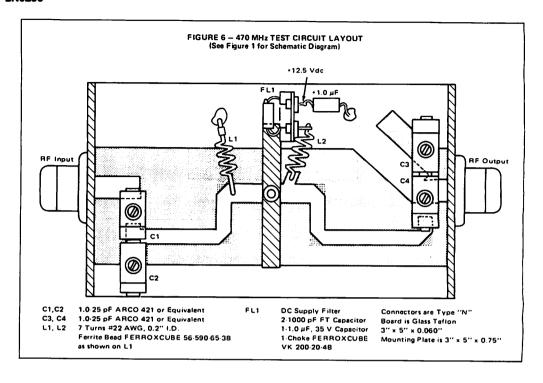
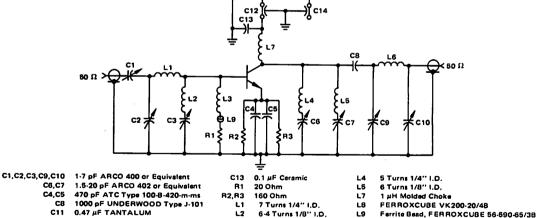


FIGURE 7 - 150 MHz to 450 MHz TRIPLER USING 2N6256



0.68 µH Molded Choke

+ 12.5 Vdc

NOTE: All coils air core space wound with #20 AWG Wire, unless otherwise specified.

L3

Figure 7 shows the 2N6258 in a 150 MHz to 450 MHz tripler circuit. This circuit will typically produce 85 mW at 450 MHz with 30 mW at 150 MHz input (4.5 dB gain). Collector efficiency is 25% and all unwanted harmonics are at least 30 dB down from the 450 MHz output level.

470 pF Feedthru

It is important that each emitter lead be bypassed separately with a good hi-quality capacitor. The emitter resistor is likewise split in two with one-half on each emitter lead.

The input network is a modified "TEE" consisting of C1, C2, and L1, which matches the 50 Ohm input to the transistor impedance at 150 mc; this is roughly 18-j20 Ohms. The combination of L2 and C3 forma 450 MHz idler to provide a base return for third harmonic current. L4, C6 and L5, C7 are 150 MHz and 300 MHz output idlers respectively. The output matching section is a pi network made up of L6, C9 and C10. All coils are air core space-wound (turns one wire diameter apart) with #20 AWG wire.

C12,C14

2N6304 2N6305

CASE 20-03, STYLE 10 TO-72 (TO-206AF)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM PATINGS

| Rating | Symbol | Value | Unit | |
|---|------------------|-------------|-------------|--|
| Collector-Emitter Voltage | VCEO | 15 | Vdc | |
| Collector-Base Voltage | V _{CBO} | 30 | Vdc | |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc | |
| Collector Current — Continuous | lc | 50 | mAdc | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 200 1.14 | mW mW/°C | |
| Storage Temperature | T _{stg} | -65 to +200 | °C | |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

Min Max Unit **Symbol** Тур Characteristic OFF CHARACTERISTICS Vdc V(BR)CEO 15 Collector-Emitter Breakdown Voltage $(I_C = 5.0 \text{ mAdc}, I_B = 0)$ 30 Vdc V(BR)CBO Collector-Base Breakdown Voltage $(I_C = 0.1 \text{ mAdc}, I_E = 0)$ Vdc V(BR)EBO Emitter-Base Breakdown Voltage $(l_E = 0.1 \text{ mAdc}, l_C = 0)$ 10 nAdc Collector Cutoff Current ICBO $(V_{CB} = 5.0 \text{ Vdc}, I_{E} = 0)$ ON CHARACTERISTICS 250 25 DC Current Gain hFE (IC = 2.0 mAdc, VCE = 5.0 Vdc) SMALL SIGNAL CHARACTERISTICS MHz ſΤ Current-Gain - Bandwidth Product 1400 (IC = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz) 2N6304 2N6305 1200 рF Ccb 0.8 1.0 Collector-Base Capacitance $(V_{CB} = 10 \text{ Vdc}, I_{E} = 0, f = 1.0 \text{ MHz})$ 250 hfe 25 Small Signal Current Gain (IC = 2.0 mAdc, VCE = 5.0 Vdc, f = 1.0 kHz) rb'Cc **Collector Base Time Constant** 2.0 12 2N6304 $(l_E = 2.0 \text{ mAdc}, V_{CB} = 5.0 \text{ Vdc}, f = 31.8 \text{ MHz})$ 2N6305 2.0 15 dB NF Noise Figure (IC = 2.0 mAdc, VCE = 5.0 Vdc, RS = 50 ohms, 4.5 2N6304 f = 450 MHz) (Figure 1) 5.5 2N6305 **FUNCTIONAL TEST** Gpe dΒ Common-Emitter Amplifier Power Gain (IC = 2.0 mAdc, V_{CE} = 5.0 Vdc, f = 450 MHz) (Figure 1) 2N6304 15

12

2N6305

FIGURE 1 - TEST CIRCUIT FOR NOISE FIGURE AND POWER GAIN

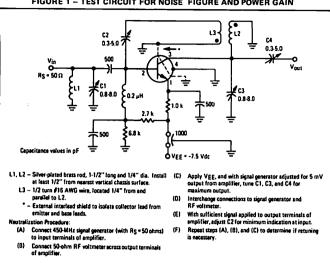


FIGURE 2 - COLLECTOR-BASE CAPACITANCE

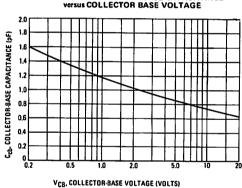


FIGURE 3 -- CURRENT-GAIN-BANDWIDTH PRODUCT Versus COLLECTOR CURRENT 2500 2250 VCE - 10 Vde FRODUCT (MH2)

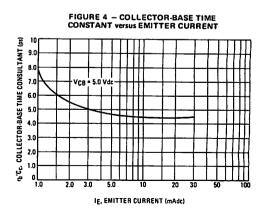
PRODUCT (MH2)

PRODUCT (MH2)

PRODUCT (MH2)

PRODUCT (MH2)

PRODUCT (MH2) VCE = 5.0 Vdc 250 IC, COLLECTOR CURRENT (mAde)



MOTOROLA SEMICONDUCTORS

FIGURE 5 - REVERSE TRANSFER
ADMITTANCE versus FREQUENCY

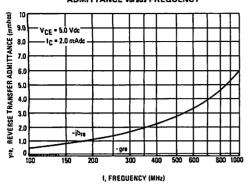


FIGURE 6 - INPUT ADMITTANCE versus FREQUENCY

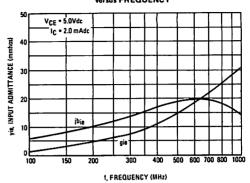


FIGURE 7 — OUTPUT ADMITTANCE versus FREQUENCY

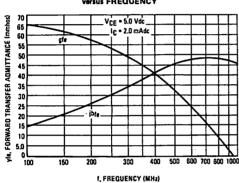
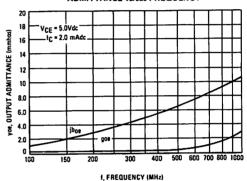


FIGURE 8 - FORWARD TRANSFER ADMITTANCE versus FREQUENCY



800

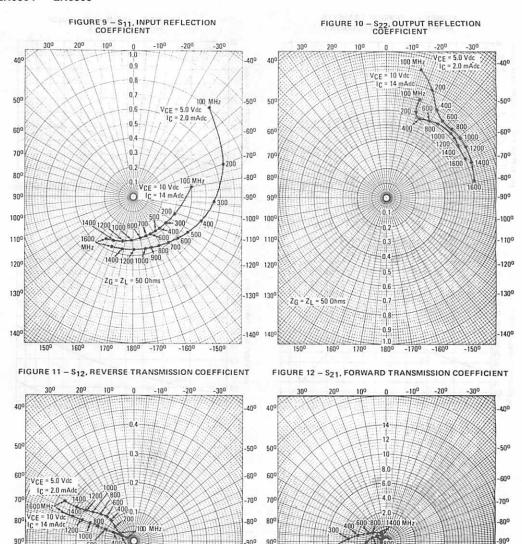
900

1000

1100

1200

1300



-800 800

-900 900

-100° 100°

-120° 120°

-130° 130°

-140º 140º

200

100 MHz

VCE = 10 Vdc IC = 14 mAdo

1500

100 MHz

VCE = 5.0 Vdc

ZG = ZL = 50 0 hms

180° -170°

Ic = 2.0 mAdc

100 MHz

-160°

ZG = ZL = 50 Ohms

1700

MOTOROLA SEMICONDUCTORS

-160°

-800

-900

-100°

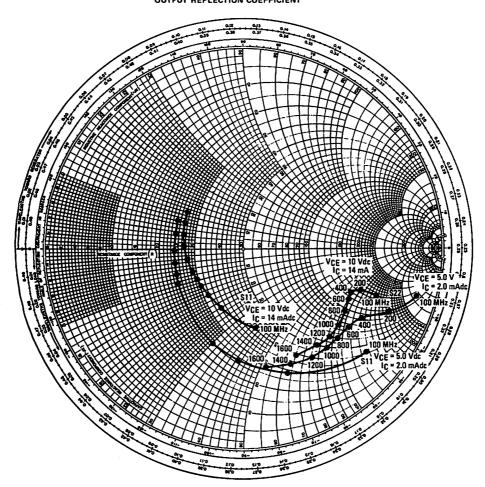
-110°

-120°

-130°

-1400

FIGURE 13 – \mathbf{S}_{11} , INPUT REFLECTION COEFFICIENT AND \mathbf{S}_{22} , OUTPUT REFLECTION COEFFICIENT



JAN, JTX, JTXV AVAILABLE CASE 303-01, STYLE 1

HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS (TA = 25°C Free Air Temperature)

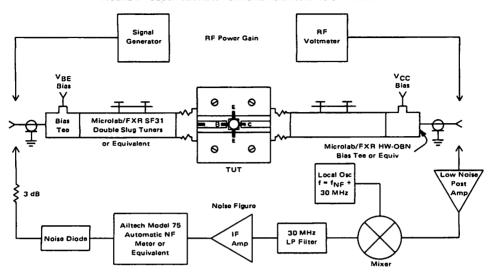
| Rating | Symbol | Value | Unit Vdc | |
|--|------------------|-------------|-------------|--|
| Collector-Emitter Voltage | VCEO | 15 | | |
| Collector-Base Voltage | V _{CBO} | 25 | Vdc | |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc | |
| Collector Current — Continuous | lc | 30 | mAdc | |
| otal Device Dissipation @ T _C = 125°C P _D Derate above 125°C | | 400 5.33 | mW mW/°C | |
| Storage Temperature | T _{stg} | -65 to +200 | °C | |

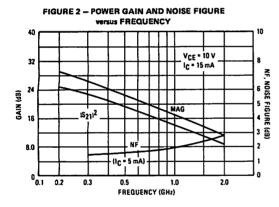
| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|-----------------|------|-----|------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) | V(BR)CEO | 15 | _ | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.1 mAdc, IE = 0) | V(BR)CBO | 25 | | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 0.1 mAdc, I _C = 0) | V(BR)EBO | 3.0 | | _ | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, I _E = 0) | ІСВО | | - | 50 | nAdc |
| ON CHARACTERISTICS | | , | | | |
| DC Current Gain (I _C = 15 mAdc, V _{CE} = 10 Vdc) | hFE | 30 | _ | 200 | _ |
| SMALL SIGNAL CHARACTERISTICS | | | | | |
| Collector-Base Capacitance(1) (VCB = 10 Vdc, $I_E = 0$, 0.1 MHz $\leq f \leq$ 1.0 MHz) | C _{cb} | 0.25 | - | 0.75 | pF |
| FUNCTIONAL TEST | | | | | |
| Common-Emitter Amplifier Power Gain (Figure 1) (VCE = 10 Vdc, IC = 15 mA, f = 1.0 GHz) | G _{pe} | 15 | - | 21 | dB |
| Spot Noise Figure (R _S = Optimum) (Figure 1) (V _{CE} = 10 Vdc, I _C = 5.0 mA, f = 1.0 GHz) | NF | 1.0 | _ | 2.5 | dB |
| Power Gain at Optimum Noise Figure (Figure 1) (VCE = 10 Vdc, IC = 5.0 mA, f = 1.0 GHz) | GNF | 10 | _ | - | dB |
| TYPICAL 2 GHz PERFORMANCE | | | | | |
| Maximum Available Gain (Figure 1)(2) (VCE = 10 Vdc, IC = 15 mA, f = 2.0 GHz) | MAG | _ | 11 | | dB |
| Noise Figure (Rs = Optimum) (Figure 1) (VCE = 10 Vdc, IC = 5.0 mA, f = 2.0 GHz) | NF | _ | 2.9 | _ | dB |

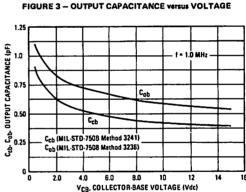
⁽¹⁾ C_{cb} measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter terminal shall be connected to the guard terminal of the bridge.

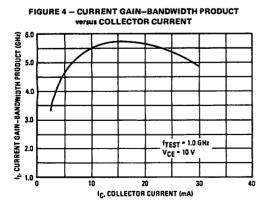
⁽²⁾ MAG is calculated from the S-Parameters using the equation MAG = $\frac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

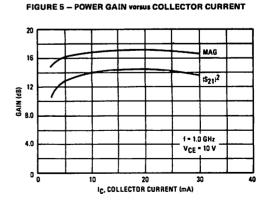
FIGURE 1 - BLOCK DIAGRAM FOR POWER GAIN AND NOISE FIGURE





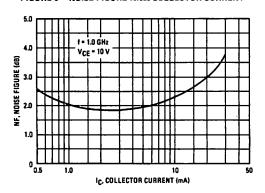






SMALL-SIGNAL DEVICES

FIGURE 8 - NOISE FIGURE versus COLLECTOR CURRENT



COMMON EMITTER SCATTERING PARAMETERS

FIGURE 7 — INPUT AND OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY

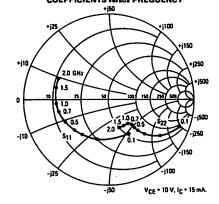
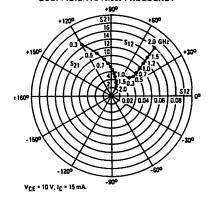


FIGURE 8 — FORWARD AND REVERSE TRANSMISSION COEFFICIENTS VOISUS FREQUENCY



| 2 - | PAR | AMF | TERS |
|-----|-----|------------|------|

| S – PARAMETERS | | | | | | | | | | |
|----------------|------|-----------|---------|------|-------|------|---------------|----|------|-----|
| VCE | lc | Frequency | S11 S21 | | S12 | | \$22 | | | |
| (Volts) | (mA) | (MHz) | IS11; | Lφ | IS21I | Lφ | IS12 I | Lφ | S22 | Lφ |
| 5.0 | 5 | 100 | 0.69 | -30 | 12.16 | 160 | 0.026 | 72 | 0.95 | -16 |
| i . | l 1 | 200 | 0.65 | -61 | 11.03 | 143 | 0.046 | 59 | 0.84 | -31 |
| 1 | 1 | 500 | 0.63 | -122 | 7.05 | 111 | 0.074 | 36 | 0.56 | -54 |
| | | 1000 | 0.64 | -158 | 4.13 | 88 | 0.087 | 28 | 0.39 | -68 |
| | h | 2000 | 0.65 | 170 | 2.14 | 61 | 0.107 | 29 | 0.33 | -91 |
| 1 | 10 | 100 | 0.52 | -50 | 18.74 | 154 | 0.022 | 69 | 0.91 | -22 |
| l | ł [| 200 | 0.54 | -92 | 15.53 | 135 | 0.037 | 53 | 0.74 | -40 |
| 1 | 1 1 | 500 | 0.62 | -146 | 8.49 | 104 | 0.052 | 38 | 0.43 | -62 |
| 1 | | 1000 | 0.65 | -172 | 4.66 | 84 | 0.065 | 37 | 0.29 | -75 |
| | | 2000 | 0.67 | 162 | 2.38 | 60 | 0.094 | 42 | 0.26 | -97 |
| 1 | 15 | 100 | 0.42 | -70 | 22.72 | 150 | 0.019 | 66 | 0.87 | -26 |
| ı | | 200 | 0.51 | -113 | 17.72 | 130 | 0.030 | 50 | 0.68 | -44 |
| | | 500 | 0.63 | -157 | 8.96 | 100 | 0.042 | 41 | 0.38 | -64 |
| 1 | 1 | 1000 | 0.66 | -178 | 4.80 | 82 | 0.056 | 44 | 0.26 | -75 |
| i | | 2000 | 0.69 | 159 | 2.43 | 59 | 0.090 | 48 | 0.24 | -97 |
| 1 | 30 | 100 | 0.39 | -116 | 24.57 | 142 | 0.014 | 62 | 0.80 | -29 |
| 1 | 1 | 200 | 0.55 | -145 | 17.17 | 120 | 0.021 | 49 | 0.58 | -42 |
| 1 | i i | 500 | 0.67 | -171 | 7.96 | 95 | 0.030 | 49 | 0.34 | -49 |
| J | 1 : | 1000 | 0.69 | 175 | 4.18 | . 78 | 0.047 | 56 | 0.29 | -56 |
| | | 2000 | 0.71 | 157 | 2.13 | 55 | 0.084 | 58 | 0.29 | -81 |
| 10 | 5 | 100 | 0.71 | -27 | 12.01 | 161 | 0.021 | 73 | 0.96 | -13 |
| 1 | [| 200 | 0.67 | -55 | 11.10 | 145 | 0.039 | 60 | 0.87 | -25 |
| 1 | 1 | 500 | 0.63 | -115 | 7.44 | 114 | 0.064 | 39 | 0.62 | -44 |
| 1 | | 1000 | 0.64 | -153 | 4.43 | 90 | 0.077 | 30 | 0.46 | -55 |
| l | | 2000 | 0.64 | 172 | 2.27 | 62 | 0.094 | 31 | 0.39 | -76 |
| 1 | 10 | 100 | 0.55 | -43 | 18.77 | 155 | 0.018 | 71 | 0.92 | -18 |
| 1 | | 200 | 0.55 | -83 | 16.00 | 137 | 0.031 | 54 | 0.78 | -32 |
| | ŀ | 500 | 0.60 | -140 | 9.06 | 106 | 0.046 | 39 | 0.49 | -48 |
| | j . | 1000 | 0.63 | -168 | 5.02 | 85 | 0.058 | 39 | 0.36 | -56 |
| | | 2000 | 0.65 | 164 | 2.55 | 60 | 0.084 | 43 | 0.33 | -76 |
| | 15 | 100 | 0.46 | -60 | 23.14 | 152 | 0.016 | 68 | 0.90 | -21 |
| 1 | 1 | 200 | 0.51 | -103 | 18.39 | 131 | 0.027 | 52 | 0.72 | -36 |
| | 1 | 500 | 0.61 | -152 | 9.67 | 102 | 0.037 | 42 | 0.43 | -49 |
| l | 1 | 1000 | 0.64 | -175 | 5.21 | 83 | 0.049 | 45 | 0.33 | -54 |
| } | | 2000 | 0.66 | 161 | 2.61 | 59 | 0.079 | 51 | 0.31 | -74 |
| ı | 30 | 100 | 0.39 | -98 | 27.29 | 144 | 0.013 | 63 | 0.83 | -24 |
| | ! | 200 | 0.53 | -135 | 19.38 | 122 | 0.019 | 50 | 0.63 | -35 |
| | 1 | 500 | 0.64 | -167 | 9.11 | 96 | 0.027 | 48 | 0.41 | -39 |
| 1 | l . | 1000 | 0.66 | 177 | 4.77 | 79 | 0.042 | 55 | 0.36 | -45 |
| | l · | 2000 | 0.69 | 157 | 2.41 | 56 | 0.074 | 58 | 0.35 | -67 |

JAN, JTX, JTXV AVAILABLE CASE 303-01, STYLE 1

HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS (TA = 25°C Free Air Temperature)

| THE STATE OF THE S | Tim Tompord | Rating Symbol Value Unit | | | |
|--|------------------|--------------------------|------------|--|--|
| Rating | Symbol | Value | Unit | | |
| Collector-Emitter Voltage | VCEO | 15 | Vdc | | |
| Collector-Base Voltage | VCBO | 25 | Vdc | | |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc | | |
| Collector Current — Continuous | lc | 50 | mAdc | | |
| Total Device Dissipation @ T _C = 125°C Derate above 125°C | PD | 500 6.66 | mW mW/℃ | | |
| Storage Temperature | T _{stg} | -65 to +200 | ů | | |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|-----------------|------|-----|------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, Ig = 0) | V(BR)CEO | 15 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.1 mAdc, IE = 0) | V(BR)CBO | 25 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 0.1 mAdc, I _C = 0) | V(BR)EBO | 3.0 | - | _ | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) | ІСВО | _ | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 30 mAdc, VCE = 10 Vdc) | hFE | 30 | _ | 200 | - |
| SMALL SIGNAL CHARACTERISTICS | | | | | • |
| Collector-Base Capacitance(1) (VCB = 10 Vdc, t _E = 0, 0.1 MHz ≤ f ≤ 1.0 MHz) | C _{cb} | 0.30 | | 0.80 | pF |
| FUNCTIONAL TEST | | | | • | • |
| Common-Emitter Amplifier Power Gain (Figure 1) (VCE = 10 Vdc, IC = 30 mAdc, f = 1.0 GHz) | G _{pe} | 15 | - | 21 | dB |
| Spot Noise Figure (R _S = Optimum) (Figure 1) (V _{CE} = 10 Vdc, I _C = 5.0 mAdc, f = 1.0 GHz) | NF | 1.5 | _ | 3.0 | dB |
| Power Gain at Optimum Noise Figure (Figure 1) (VCE = 10 Vdc, IC = 5.0 mAdc, f = 1.0 GHz) | GNF | 9.0 | _ | _ | dB |
| TYPICAL 2 GHz PERFORMANCE | | | | | |
| Maximum Available Gain (Figure 1)(2) (VCE = 10 Vdc, IC = 30 mAdc, f = 2.0 GHz) | MAG | _ | 10 | - | dB |
| Noise Figure (R _S = Optimum) (Figure 1) (V _{CE} = 10 Vdc, I _C = 5.0 mAdc, f = 2.0 GHz) | NF | _ | 4.3 | | dB |

⁽¹⁾ C_{cb} measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter terminal shall be connected to the guard terminal of the bridge.

(2) MAG is calculated from the S-Parameters using the equation MAG = $\frac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

FIGURE 1 - BLOCK DIAGRAM FOR POWER GAIN AND NOISE FIGURE

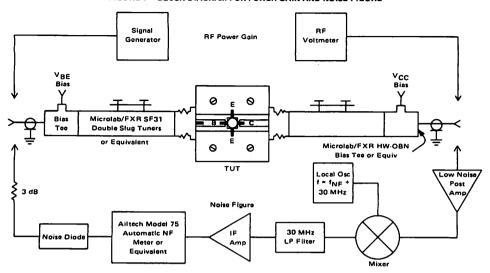


FIGURE 2 - POWER GAIN AND NOISE FIGURE versus FREQUENCY 40 V_{CE} = 10 V I_C = 30 mA 32 NF, NOISE FIGURE (dB) GAIN (dB) 15₂₁1² MAG 16 NF (Ic = 5 mA) 0.1 0.2 0.5 2.0 FREQUENCY (GHz)

FIGURE 3 – OUTPUT CAPACITANCE versus VOLTAGE

2.0

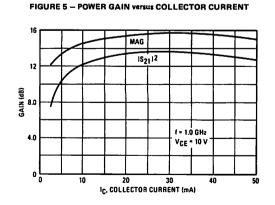
1.0

Cob

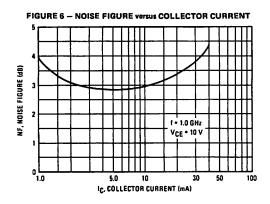
Cob

MILSTD-7508 Method 3241)
Cob (MILSTD-7508 Method 3235)

V_{CS}, COLLECTOR-BASE VOLTAGE (Vdc)



SMALL-SIGNAL DEVICES



COMMON EMITTER SCATTERING PARAMETERS

FIGURE 7 — INPUT AND OUTPUT REFLECTION COEFFICIENTS Versus FREQUENCY

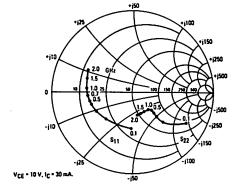
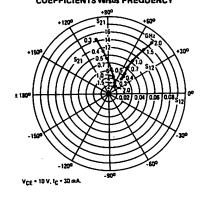


FIGURE 8 — FORWARD AND REVERSE TRANSMISSION COEFFICIENTS Versus FREQUENCY



S - PARAMETERS

| | | | | S – PARA | ME I ERS | | | | | |
|---------|------|-----------|-------|----------|----------|-----|-------|----|-------|-----|
| VCE | lc | Frequency | | 11 | S | 21 | S1 | 2 | s | 22 |
| (Volts) | (mA) | (MHz) | IS11I | Lφ | S21 | Lφ | IS12I | Lφ | IS221 | Lφ |
| 5.0 | 5 | 100 | 0.72 | -40 | 12.37 | 153 | 0.028 | 67 | 0.91 | -18 |
| | } | 200 | 0.65 | -78 | 10.38 | 133 | 0.048 | 51 | 0.76 | -32 |
| | ĺ | 500 | 0.61 | -137 | 5.75 | 100 | 0.067 | 34 | 0.50 | -45 |
| | | 1000 | 0.61 | -168 | 3.13 | 78 | 0.082 | 31 | 0.41 | -54 |
| | | 2000 | 0.63 | 161 | 1.58 | 47 | 0.112 | 30 | 0.41 | -80 |
| | 10 | 100 | 0.57 | -60 | 19.54 | 146 | 0.024 | 63 | 0.85 | -27 |
| | i | 200 | 0.55 | -105 | 14.70 | 125 | 0.038 | 47 | 0.64 | -43 |
| | Į. | 500 | 0.59 | -165 | 7.12 | 95 | 0.051 | 39 | 0.37 | -55 |
| | ļ | 1000 | 0.61 | -178 | 3.77 | 76 | 0.069 | 40 | 0.29 | -62 |
| | | 2000 | 0.64 | 156 | 1.91 | 50 | 0.106 | 39 | 0.30 | -86 |
| | 30 | 100 | 0.43 | -111 | 30.58 | 135 | 0.016 | 57 | 0.72 | -39 |
| | | 200 | 0.53 | -145 | 19.35 | 114 | 0.022 | 49 | 0.46 | -57 |
| l | | 500 | 0.62 | -173 | 8.42 | 91 | 0.035 | 51 | 0.24 | -69 |
| | | 1000 | 0.63 | 172 | 4.36 | 75 | 0.058 | 54 | 0.18 | -76 |
| | | 2000 | 0.67 | 151 | 2.19 | 52 | 0.099 | 49 | 0.21 | -99 |
| | 50 | 100 | 0.46 | -134 | 32.34 | 129 | 0.013 | 57 | 0.64 | -42 |
| | l | 200 | 0.57 | -158 | 19.19 | 110 | 0.018 | 51 | 0.40 | -56 |
| | i | 500 | 0.64 | -178 | 8.13 | 89 | 0.031 | 57 | 0.22 | -62 |
| | , | 1000 | 0.65 | 170 | 4.17 | 74 | 0.053 | 58 | 0.19 | -70 |
| | ļ | 2000 | 0.70 | 150 | 2.10 | 52 | 0.092 | 54 | 0.22 | -97 |
| 10 | 5 | 100 | 0.74 | -36 | 12.34 | 154 | 0.023 | 69 | 0.93 | -15 |
| | | 200 | 0.67 | -71 | 10.56 | 135 | 0.040 | 54 | 0.81 | -25 |
| | | 500 | 0.59 | -131 | 6.09 | 102 | 0.058 | 37 | 0.57 | -36 |
| | l | 1000 | 0.58 | -164 | 3.32 | 79 | 0.073 | 33 | 0.50 | -44 |
| | | 2000 | 0.60 | 164 | 1.67 | 48 | 0.098 | 32 | 0.49 | -69 |
| | 10 | 100 | 0.60 | -52 | 19.75 | 148 | 0.020 | 65 | 0.87 | -21 |
| | | 200 | 0.56 | -95 | 15.30 | 127 | 0.032 | 49 | 0.69 | -33 |
| | | 500 | 0.56 | -149 | 7.69 | 97 | 0.044 | 41 | 0.45 | -41 |
| | | 1000 | 0.58 | -174 | 4.07 | 77 | 0.061 | 42 | 0.39 | -47 |
| | | 2000 | 0.61 | 159 | 2.03 | 50 | 0.095 | 40 | 0.39 | -70 |
| | 30 | 100 | 0.44 | -94 | 32.03 | 136 | 0.014 | 59 | 0.75 | -31 |
| | | 200 | 0.50 | -135 | 20.76 | 115 | 0.021 | 49 | 0.52 | -41 |
| | | 500 | 0.57 | -168 | 9.13 | 91 | 0.032 | 52 | 0.33 | -43 |
| | | 1000 | 0.59 | 175 | 4.71 | 75 | 0.052 | 54 | 0.29 | -48 |
| i | | 2000 | 0.64 | 154 | 2.34 | 52 | 0.089 | 49 | 0.30 | -72 |
| | 50 | 100 | 0.44 | -117 | 33.56 | 129 | 0.012 | 59 | 0.68 | -31 |
| | | 200 | 0.52 | -150 | 19.94 | 109 | 0.017 | 50 | 0.47 | -36 |
| | | 500 | 0.59 | -174 | 8.52 | 89 | 0.028 | 56 | 0.34 | -35 |
| | | 1000 | 0.61 | 173 | 4.38 | 75 | 0.049 | 57 | 0.32 | -43 |
| | | 2000 | 0.66 | 152 | 2.21 | 51 | 0.083 | 52 | 0.34 | -70 |

BFR90

CASE 317A-01, STYLE 2
HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MINNIMON IN INCO | | | |
|---|--------|-------------|-------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 15 | Vdc |
| Collector-Base Voltage | VCBO | 20 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | lc | 30 | mAdc |
| Total Device Dissipation @ T _A = 60°C Derate above 60°C | PD | 180 2.0 | mW mW/°C |
| Storage Temperature | Tstg | -65 to +150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|-----------------|-----|------|
| Thermal Resistance, Junction to Ambient | $R_{\theta JA}$ | 500 | •c/w |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|------------------|-----|------------|--------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAde, Ig = 0) | V(BR)CEO | 15 | | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.1 mAdc, IE = 0) | V(BR)CBO | 20 | _ | - | Vdc |
| Emitter-Base Broakdown Voltage (I _E = 0.1 mAdc, I _C = 0) | V(BR)EBO | 3.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 10 Vdc, Ig = 0) | ІСВО | _ | | 50 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 14 mAdc, VCE = 10 Vdc) | pŁE | 25 | _ | 250 | |
| SMALL SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 14 mAde, VCE = 10 Vdc, f = 0.5 GHz) | fτ | | 5.0 | _ | GHz |
| Collector-Base Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | C _{cb} | _ | 0.5 | 1.0 | pF |
| FUNCTIONAL TEST | | | | , | |
| Noise Figure (IC = 2.0 mAdc, VCE = 10 Vdc, f = 0.5 GHz) (IC = 2.0 mAdc, VCE = 10 Vdc, f = 1.0 GHz) | NF | _ | 2.4 3.0 | | dB |
| Power Gain at Optimum Noise Figure (IC = 2.0 mAdc, VCE = 10 Vdc, f = 0.5 GHz) (IC = 2.0 mAdc, VCE = 10 Vdc, f = 1.0 GHz) | G _{NF} | = | 15 10 | = | dB |
| Maximum Available Power(1) (IC = 14 mAdc, VCE = 10 Vdc, f = 0.5 GHz) (IC = 14 mAdc, VCE = 10 Vdc, f = 1.0 GHz) | G _{max} | | 18 12 | _ | dB |

(1) $G_{\text{max}} = \frac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

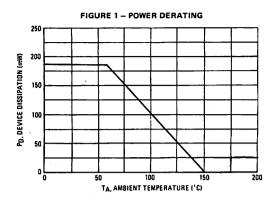


FIGURE 2 – POWER GAIN AND NOISE FIGURE VOISUS FREQUENCY

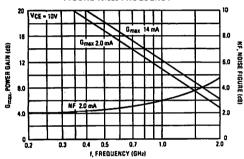


FIGURE 3 — POWER GAIN AND NOISE FIGURE VERSUS COLLECTOR CURRENT

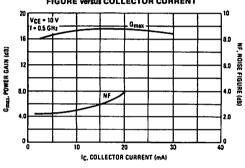


FIGURE 4 - S₁₁ PARAMETERS

| Frequenc | y (MHz) | 20 | 00 | 500 | | 8 | 00 | 1000 | | 1500 | |
|----------------------------|------------|------|------|------|------|------------|------|------|------|------|-----|
| V _{CE} (Volts) | IC (mA) | S11 | LΦ | S11 | Lφ | S11 | LΦ | S11 | LΦ | S11 | Lφ |
| | 2.0 | 0.77 | -45 | 0.48 | -90 | 0.33 | -125 | 0.27 | -160 | 0.28 | 170 |
| 5.0 | 5.0 | 0.52 | -60 | 0.25 | -110 | 0.18 | -150 | 0.18 | 170 | 0.21 | 145 |
| | 10 | 0.33 | -75 | 0.15 | -125 | 0.13 | -175 | 0.15 | 150 | 0.20 | 130 |
| | 20 | 0.20 | -95 | 0.12 | -155 | 0.14 | 165 | 0.17 | 145 | 0.22 | 130 |
| | 30 | 0.17 | -116 | 0.14 | -170 | 0.17 | 160 | 0.21 | 145 | 0.26 | 130 |
| | 2.0 | 0.79 | -40 | 0.50 | -80 | 0.33 | ·115 | 0.26 | -150 | 0.25 | 175 |
| - 1 | 5.0 | 0.56 | -55 | 0.27 | -95 | 0.16 | -135 | 0.13 | -175 | 0.17 | 150 |
| 10 | 10 | 0.39 | -65 | 0.16 | -105 | 0.10 | -150 | 0.10 | 165 | 0.15 | 140 |
| | 20 | 0.25 | -75 | 0.10 | -120 | 0.09 | -175 | 0.12 | 150 | 0.18 | 130 |
| j | 30 | 0.25 | -75 | 0.10 | -120 | 0.09 | -175 | 0.12 | 150 | 0.18 | 130 |

FIGURE 5 - \$22 PARAMETERS

| | 40.00 | | | | | | | | | | -00 |
|----------------|------------|------|-----|------|-----|------|-----|------|-----|------|---------------|
| Frequenc | y (MHz) | 2 | 00 | 50: | 0 | 80 | ю | 10 | 00 | 18 | 00 |
| VCE (Volts) | IC (mA) | S22 | 40 | S22 | Lφ | S22 | 40 | S22 | | S22 | 4 |
| 100.00 | 2.0 | 0.89 | -20 | 0.69 | -30 | 0.61 | -35 | 0.55 | -35 | 0.52 | -45 |
| | 5.0 | 0.75 | -25 | 0.55 | -30 | 0.50 | -30 | 0.47 | -30 | 0.43 | -40 |
| 5.0 | 10 | 0.64 | -25 | 0.49 | -25 | 0.45 | -25 | 0.43 | -30 | 0.40 | -35 |
| 1 | 20 | 0.57 | -25 | 0.47 | -20 | 0.44 | -25 | 0.43 | -25 | 0.40 | -35 |
| | 30 | 0.55 | -20 | 0.47 | -20 | 0.46 | -20 | 0.44 | -25 | 0.42 | -35 |
| | 2.0 | 0.91 | -15 | 0.74 | -25 | 0.66 | -30 | 0.62 | -35 | 0.59 | -40 |
| ŀ | 5.0 | 0.79 | -20 | 0.61 | -25 | 0.56 | -25 | 0.54 | -30 | 0.51 | -35 |
| 10 | 10 | 0.70 | -20 | 0.56 | -20 | 0.53 | -25 | 0.51 | -25 | 0.48 | -35 |
| | 20 | 0.63 | -20 | 0.54 | -25 | 0.53 | -20 | 0.51 | -25 | 0.49 | -35 |
| | 30 | 0.63 | -15 | 0.56 | -15 | 0.55 | -20 | 0.54 | -25 | 0.52 | -35 |

FIGURE 6 - S21 PARAMETERS

| Frequenc | y (MHz) | 20 | 0 | 50 | 0 | 80 | 0 | 100 | X | 150 | 00 |
|----------------------------|------------|-------|-----------|------|-----|------|----|------|----------|------|----|
| V _{CE} (Volts) | IC (mA) | S21 | ــ | S21 | 40 | S21 | LΦ | S21 | LΦ | S21 | LΦ |
| | 2.0 | 5.76 | 140 | 3.81 | 105 | 2.73 | 90 | 2.20 | 75 | 1.70 | 60 |
| | 5.0 | 9.92 | 125 | 5.24 | 95 | 3.50 | 80 | 2.80 | 70 | 2.10 | 60 |
| 5.0 | 10 | 12.33 | 115 | 5.82 | 90 | 3.79 | 75 | 2.90 | 65 | 2.20 | 55 |
| | 20 | 13.62 | 105 | 6.00 | 85 | 3.88 | 75 | 2.95 | 65 | 2.25 | 55 |
| | 30 | 13.41 | 105 | 5.80 | 80 | 3.74 | 75 | 2.85 | 65 | 2.15 | 55 |
| | 2.0 | 5.77 | 145 | 3.88 | 110 | 2.80 | 90 | 2.25 | 75 | 1.75 | 60 |
| l | 5.0 | 10.05 | 130 | 5.42 | 95 | 3.60 | 80 | 2.85 | 70 | 2.10 | 60 |
| 10 | 10 | 12.56 | 115 | 6.00 | 90 | 3.90 | 80 | 3.05 | 70 | 2.25 | 55 |
| | 20 | 13,77 | 110 | 6.13 | 85 | 3.92 | 75 | 3.05 | 65 | 2.20 | 55 |
| | 30 | 13.23 | 105 | 5.79 | 85 | 3.70 | 75 | 2.85 | 65 | 2.15 | 55 |

FIGURE 7 - S12 PARAMETERS

| Frequenc | y (MHz) | 200 | | 500 | | 800 | | 1000 | | 1500 | |
|----------|---------|------|----|------|----|------|----|------|----|------|----|
| VCE | ¹c | | | | | | | | | | |
| (Volts) | (mA) | S12 | LΦ | \$12 | LΦ | S12 | LΦ | S12 | 4 | S12 | LΦ |
| | 2.0 | 0.06 | 65 | 0.10 | 55 | 0.12 | 55 | 0.14 | 55 | 0.17 | 60 |
| | 5.0 | 0.05 | 65 | 0.08 | 65 | 0.12 | 65 | 0.15 | 65 | 0.19 | 65 |
| 5.0 | 10 | 0.04 | 65 | 0.08 | 70 | 0.12 | 70 | 0.15 | 70 | 0.20 | 65 |
| | 20 | 0.04 | 75 | 0.08 | 75 | 0.12 | 75 | 0.15 | 70 | 0.20 | 70 |
| | 30 | 0.03 | 75 | 0.07 | 75 | 0.11 | 75 | 0.15 | 75 | 0.19 | 70 |
| | 2.0 | 0.05 | 70 | 0.03 | 55 | 0.11 | 55 | 0.12 | 55 | 0.15 | 60 |
| l | 5.0 | 0.04 | 65 | 0.07 | 65 | 0.10 | 65 | 0.13 | 65 | 0.17 | 70 |
| 10 | 10 | 0.04 | 65 | 0.07 | 70 | 0.10 | 70 | 0.13 | 70 | 0.17 | 70 |
| Ī | 20 | 0.03 | 70 | 0.07 | 75 | 0.10 | 75 | 0.13 | 75 | 0.17 | 70 |
| | 30 | 0.03 | 75 | 0.06 | 75 | 0.10 | 75 | 0.13 | 75 | 0.17 | 70 |

MAXIMUM RATINGS

| MINOVINION INVINION | | | |
|--|------------------|-------------|-------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 12 | Vdc |
| Collector-Base Voltage | V _{CBO} | 15 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | lc | 35 | mAdc |
| Total Device Dissipation @ T _A = 60°C Derate above 60°C | PD | 180 2.0 | mW mW/°C |
| Storage Temperature | T _{stq} | -65 to +150 | °C |

THERMAL CHARACTERISTICS

| IIIEIIIIAE OIMIMOTEIROTTO | | | |
|---|--------|-----|------|
| Characteristic | Symbol | Max | Unit |
| Thermal Resistance, Junction to Ambient | RAJA | 500 | °C/W |

BFR91

CASE 317A-01, STYLE 2
HIGH FREQUENCY TRANSISTOR
NPN SILICON

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|------------------|-----|------------|--------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) | V(BR)CEO | 12 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 0.1 mAdc, I _E = 0) | V(BR)CBO | 15 | _ | | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 0.1 mAdc, I _C = 0) | V(BR)EBO | 3.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 5.0 Vdc, IE = 0) | ІСВО | 1 | | 50 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 30 mAdc, VCE = 5.0 Vdc) | hFE | 25 | _ | 250 | _ |
| SMALL SIGNAL CHARACTERISTICS | _ | | | | |
| Current-Gain — Bandwidth Product (I _C = 30 mAdc, V _{CE} = 5.0 Vdc, f = 0.5 GHz) | fΤ | _ | 5.0 | - | GHz |
| Collector-Base Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | C _{cb} | | 0.7 | 1.0 | pF |
| FUNCTIONAL TEST | | | | | |
| Noise Figure (I _C = 2.0 mAdc, V _{CE} = 5.0 Vdc, f = 0.5 GHz) (I _C = 2.0 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 GHz) | NF | _ | 1.9 2.5 | _ | dB |
| Power Gain at Optimum Noise Figure (I _C = 2.0 mAdc, V _{CE} = 5.0 Vdc, f = 0.5 GHz) (I _C = 2.0 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 GHz) | G _{NF} | _ | 11 8.0 | | dB |
| Maximum Available Power(1) (IC = 30 mAdc, VCE = 5.0 Vdc, f = 0.5 GHz) (IC = 30 mAdc, VCE = 5.0 Vdc, f = 1.0 GHz) | G _{max} | _ | 16 10 | = | dB |

(1) $G_{\text{max}} = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$

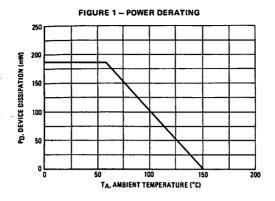
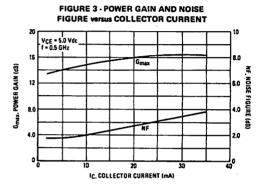


FIGURE 2 - POWER GAIN AND NOISE FIGURE versus FREQUENCY G_{max}, POWER GAIN (dB) 12 20 mA 8.0 NF 2.0 mA 4.0 0.3 0.4 0.5 0.7 1.0 f. FREQUENCY (GHz)



0.25 145

FIGURE 4 - S₁₁ PARAMETERS Frequency (MHz) 200 500 800 1000 1500 VCE IC (Volts) (mA) **S11** 4 **S11** LΦ **S11** LΦ **S11** 4 **S11** LΦ 2.0 0.72 -65 0.51 -125 -165 0.46 0,47 170 0.51 145 -90 0.35 5.0 0.49 -150 0.34 175 0.36 155 0.41 135 5.0 10 0.34 -110 0.28 -165 0.29 165 0.32 145 0.36 130 20 0.26 -130 0.24 180 0.27 155 0.30 140 0.34 125 30 0.24 -145 0.24 175 0.27 155 140 0.30 0.34 125 2.0 0.74 -60 0.51 -120 0.45 -160 0.45 170 0.49 150 5.0 0.52 -80 0.33 -140 0.31 -175 0.32 160 145 0.37 10 -95 -155 170 10 0.36 0.24 0.24 0.27 155 0.31 140 0.19 20 0.25 -115 -170 0.21 160 0.24 145 0.29 130 30 0.22 -120 0.19 -175

0.21 160

| Frequenc | y (MHz) | 20 | 0 | 50 | 0 | 80 | 0 | 100 | 0 | 150 | 00 |
|----------|------------|------|-----|------|------------|------|-----|------|-------------|------|------------|
| (Volts) | IC (mA) | S22 | Lø | S22 | L φ | S22 | Lφ | \$22 | Lφ . | \$22 | L Φ |
| | 2.0 | 0.83 | -25 | 0.62 | -35 | 0.55 | -40 | 0.51 | -45 | 0.49 | -60 |
| | 5.0 | 0.66 | -30 | 0.45 | -35 | 0.40 | -40 | 0.37 | -40 | 0,34 | -50 |
| 5.0 | 10 | 0.52 | -35 | 0.36 | -35 | 0.32 | -35 | 0.30 | -35 | 0.27 | -50 |
| | 20 | 0.42 | -35 | 0.30 | -30 | 0.27 | -30 | 0.26 | -30 | 0.22 | -45 |
| | 30 | 0.38 | -35 | 0.28 | -25 | 0.26 | -30 | 0.25 | -30 | 0.21 | -40 |
| | 2.0 | 0.86 | -20 | 0.67 | -30 | 0.62 | -35 | 0.58 | -40 | 0.56 | -50 |
| | 5.0 | 0.71 | -25 | 0.53 | -30 | 0.48 | -30 | 0.45 | -35 | 0.43 | -45 |
| 10 | 10 | 0.59 | -30 | 0.45 | -25 | 0.41 | -30 | 0.40 | -30 | 0.37 | -40 |
| | 20 | 0.50 | -25 | 0.40 | -25 | 0.38 | -25 | 0.37 | -30 | 0.34 | -40 |
| | 30 | 0.47 | -25 | 0.40 | -20 | 0.38 | -25 | 0.37 | -30 | 0.34 | 35 |

0.20 130

FIGURE 6 - S21 PARAMETERS

| Frequence | y (MHz) | 200 | | 50 | 0 | 80 | 0 | 100 | 00 | 150 | ю |
|----------------------------|------------------------|-------|-----|------|------------|------|----|------|----|------|------------|
| V _{CE} (Volts) | I _C (mA) | S21 | LΦ | S21 | <i>ι</i> φ | S21 | LΦ | \$21 | LΦ | S21 | <i>1</i> φ |
| | 2.0 | 5.25 | 130 | 3.06 | 95 | 2.10 | 75 | 1.70 | 65 | 1.20 | 50 |
| | 5.0 | 8.72 | 120 | 4.34 | 90 | 2.84 | 75 | 2.30 | 65 | 1.60 | 50 |
| 5.0 | 10 | 10.85 | 110 | 4.92 | 85 | 3.22 | 70 | 2.60 | 65 | 1.80 | 50 |
| | 20 | 12.13 | 105 | 5.34 | 80 | 3.44 | 70 | 2.75 | 60 | 1.90 | 50 |
| | 30 | 12.50 | 100 | 5.42 | 80 | 3.47 | | 2.75 | 60 | 1,90 | 50 |
| | 2.0 | 5.36 | 135 | 3.20 | 95 | 2.20 | 80 | 1.85 | 65 | 1.30 | 50 |
| 10 | 5.0 | 9.05 | 120 | 4.55 | 90 | 3.00 | 75 | 2.45 | 65 | 1.65 | 50 |
| | 10 | 11.37 | 110 | 5.22 | 85 | 3.40 | 75 | 2.65 | 65 | 1.85 | 50 |
| | 20 | 12.83 | 105 | 5.64 | 80 | 3.63 | 70 | 2.75 | 60 | 2.00 | 50 |
| | 30 | 13.10 | 100 | 5.62 | 80 | 3.63 | 70 | 2.75 | 60 | 2.00 | 50 |

FIGURE 7 - S12 PARAMETERS

| | | | | FIGUR | E / - 31 | 2 PARAME I C | no | | | | |
|----------------------------|------------|------|------|-------|------------|--------------|-----|------|-----|------|----|
| Frequency | (MHz) | 20 | 0 | 50 | 0 | 80 | 0 | 100 | 00 | 150 | 0 |
| V _{CE} (Volts) | IC (mA) | S12 | l.\$ | S12 | <i>L</i> φ | S12 | L Ø | \$12 | L Ø | S12 | ۷φ |
| 7.7 | 2.0 | 0.08 | 55 | 0.11 | 45 · | 0.12 | 50 | 0.14 | 55 | 0.17 | 65 |
| | 5.0 | 0.06 | 55 | 0.09 | 60 | 0.13 | 65 | 0.17 | 65 | 0.22 | 65 |
| 5.0 | 10 | 0.05 | 60 | 0.09 | 65 | 0.14 | 70 | 0.19 | 65 | 0.24 | 65 |
| | 20 | 0.05 | 70 | 0.07 | 70 | 0.15 | 70 | 0.19 | 70 | 0.25 | 65 |
| | 30 | 0.04 | 75 | 0,10 | 75 | 0.15 | 70 | 0.19 | 70 | 0.25 | 65 |
| | 2.0 | 0.06 | 60 | 0.09 | 45 | 0.10 | 50 | 0.12 | 60 | 0.15 | 70 |
| | 5.0 | 0.05 | 60 | 0.08 | 60 | 0.11 | 65 | 0.15 | 65 | 0.19 | 70 |
| 10 | 10 | 0.05 | 65 | 0.08 | 65 | 0.12 | 70 | 0.16 | 70 | 0.21 | 70 |
| | 20 | 0.04 | 70 | 0.08 | 70 | 0.13 | 70 | 0.17 | 70 | 0.22 | 70 |
| | 30 | 0.04 | 70 | 0.08 | 75 | 0.13 | 70 | 0.17 | 70 | 0.22 | 70 |

BFR96

CASE 317A-01, STYLE 2

MRF961

CASE 317-01, STYLE 2

MRF962

CASE 303-01, STYLE 1

MRF965

CASE 26-03, STYLE 1 TO-46 (TO-206AB)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| INVINION WALLIAGO | | | | |
|---|------------------|------------------|------------------|----------------|
| Rating | Symbol | BRF96 MRF961 | MRF962 MRF965 | Unit |
| Collector-Emitter Voltage | VCEO | 15 | 15 | Vdc |
| Collector-Base Voltage | VCBO | 20 | 20 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | 3.0 | Vdc |
| Collector Current — Continuous | l _C | 100 | 100 | mAdc |
| Total Device Dissipation @ T _C = 100°C Derate above 100°C | PD | 0.5 5.0 | 0.75 7.5 | Watts mW/°C |
| Storage Temperature | T _{stg} | - 65 to + 150 | -65 to +200 | °C |

Symbol Min Typ Max Unit

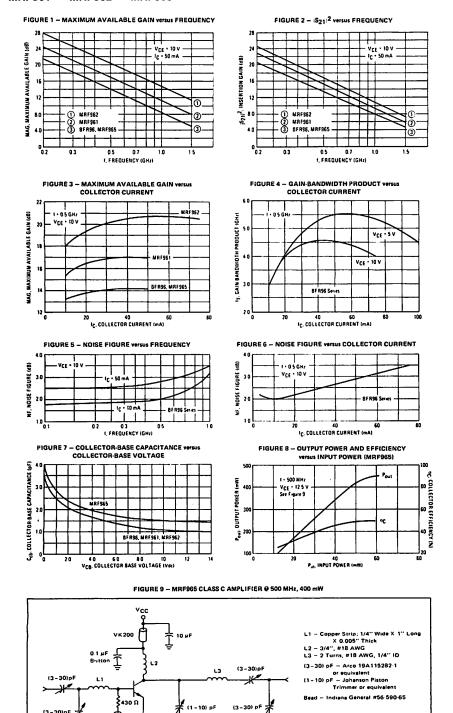
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic

| V(BR)CEO | 15 | _ | - | Vdc |
|-------------------------------------|------------------------------------|---|---|---|
| V(BR)CBO | 20 | - | _ | Vdc |
| V(BR)EBO | 3.0 | _ | _ | Vdc |
| ісво | _ | - | 100 | nAdc |
| | | | | |
| hFE | 30 | _ | 200 | _ |
| | | | | |
| fΤ | _ | 4.5 | _ | GHz |
| C _{cb} | _ | 1.2 1.6 | 1.5 2.0 | pF |
| | | | - | |
| NF | _ | 2.0 | | dB |
| MAG/ S ₂₁ ² | -/12 -/13.5 -/15 | 14.5/13 17/15 20.5/16.5 | - | dB |
| · · · · · | V(BR)CBO V(BR)EBO ICBO IFE fT Ccb | V(BR)CBO 20 V(BR)EBO 3.0 ICBO — hFE 30 fT — Ccb — NF — MAG/ S21 ² —/12 —/13.5 | V(BR)CBO 20 — V(BR)EBO 3.0 — ICBO — — hFE 30 — fT — 4.5 Ccb — 1.2 — 1.6 NF — 2.0 MAG/ S ₂₁ ² —/12 14.5/13 —/13.5 17/15 | V(BR)CBO 20 — — V(BR)EBO 3.0 — — ICBO — — 100 hFE 30 — 200 fT — 4.5 — Ccb — 1.2 1.5 — 1.6 2.0 NF — 2.0 — MAG/ S ₂ 1 ² — 12.5 — 17/15 — |

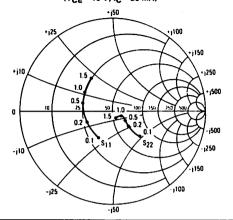
NOTE 1. MAG =
$$\frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$$

BFR96 • MRF961 • MRF962 • MRF965

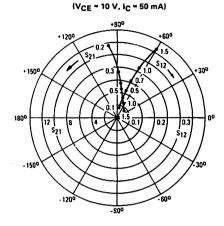


BFR96 COMMON-EMITTER S-PARAMETERS

INPUT/OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY (VCE = 10 V, IC = 50 mA)



FORWARD/REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY

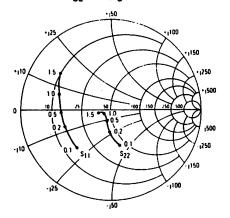


| VCE | ΙC | f | S | 1 | S: | 21 | S ₁ | 2 | s | 22 |
|---------|------|-------|--------------------|------|-------|------|--------------------|----|-------|------|
| (Volts) | (mA) | (MHz) | IS ₁₁ ! | Lφ | S21! | 40 | IS ₁₂ I | 40 | IS221 | 40 |
| 5.0 | 10 | 100 | 0.51 | -95 | 15.04 | 121 | 0.047 | 54 | 0.58 | -48 |
| | | 300 | 0.43 | -163 | 5.87 | 92 | 0.082 | 58 | 0.26 | -63 |
| | | 500 | 0.46 | 174 | 3.61 | 79 | 0.120 | 63 | 0.19 | -63 |
| | | 700 | 0.48 | 162 | 2.65 | 68 | 0.161 | 63 | 0.15 | -64 |
| | | 1000 | 0.48 | 146 | 1.92 | 57 | 0.220 | 63 | 0.12 | -79 |
| | | 1500 | 0.54 | 121 | 1.40 | 43 | 0.320 | 58 | 0.13 | -118 |
| - [| 25 | 100 | 0.39 | -122 | 19.41 | 112 | 0.037 | 60 | 0.42 | -68 |
| | | 300 | 0.39 | -176 | 6.81 | 89 | 0.079 | 68 | 0.16 | -94 |
| | | 500 | 0.42 | 166 | 4.11 | 78 | 0.129 | 70 | 0.10 | -103 |
| | | 700 | 0.44 | 156 | 3.05 | 69 | 0.176 | 68 | 0.06 | -119 |
| | | 1000 | 0.44 | 142 | 2.20 | 59 | 0.244 | 64 | 0.06 | -159 |
| | | 1500 | 0.49 | 118 | 1.62 | 45 | 0.348 | 57 | 0.10 | 177 |
| | 50 | 100 | 0.35 | -140 | 21.10 | 106 | 0.032 | 64 | 0.33 | -81 |
| | | 300 | 0.38 | 176 | 7.11 | 88 | 0.081 | 72 | 0.13 | -116 |
| | | 500 | 0.42 | 162 | 4.28 | 78 | 0.133 | 72 | 0.09 | -136 |
| | | 700 | 0.43 | 153 | 3.16 | 70 | 0.183 | 69 | 0.07 | -163 |
| | | 1000 | 0.42 | 140 | 2.28 | 60 | 0.252 | 65 | 0.08 | 165 |
| | | 1500 | 0.47 | 116 | 1.66 | 47 | 0.357 | 57 | 0.12 | 155 |
| 10 | 10 | 100 | 0.53 | -83 | 15.96 | 124 | 0.039 | 58 | 0.65 | -36 |
| i | | 300 | 0.38 | -154 | 6.44 | 94 | 0.070 | 59 | 0.35 | -41 |
| 1 | | 500 | 0.41 | -179 | 3.98 | 81 | 0.102 | 64 | 0.30 | -39 |
| | | 700 | 0.42 | 166 | 2.94 | 70 | 0.138 | 65 | 0.27 | -39 |
| | | 1000 | 0.42 | 151 | 2.12 | 60 | 0.191 | 66 | 0.24 | -47 |
| i | | 1500 | 0.49 | 125 | 1.50 | 44 | 0.278 | 63 | 0.22 | -72 |
| Ī | 25 | 100 | 0.38 | -104 | 20.85 | 115 | 0.032 | 60 | 0.48 | -48 |
| | | 300 | 0.32 | -169 | 7.54 | 91 | 0.070 | 68 | 0.23 | -48 |
| | 1 | 500 | 0.35 | 170 | 4.61 | 80 | 0.109 | 71 | 0.19 | -43 |
| | | 700 | 0.37 | 160 | 3.37 | 70 | 0.152 | 69 | 0.16 | -39 |
| - 1 | | 1000 | 0.37 | 146 | 2.43 | 61 | 0.210 | 67 | 0.13 | -44 |
| ì | | 1500 | 0.43 | 121 | 1.73 | 47 | 0.304 | 61 | 0.10 | -74 |
| | 50 | 100 | 0.33 | -119 | 22.59 | 109 | 0.029 | 63 | 0.39 | -51 |
| | | 300 | 0.30 | -176 | 7.74 | 88 | 0.069 | 72 | 0.19 | -47 |
| | 1 | 500 | 0.34 | 166 | 4.70 | 79 | 0.113 | 73 | 0.16 | -40 |
| Į | i | 700 | 0.36 | 158 | 3.45 | 70 | 0.156 | 70 | 0.14 | -35 |
| | | 1000 | 0.36 | 144 | 2.46 | 61 | 0.217 | 66 | 0,11 | -39 |
| ļ | | 1500 | 0.42 | 119 | 1.75 | l 47 | 0.310 | 60 | 0.08 | -72 |

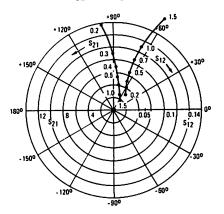
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MRF961 COMMON-EMITTER S-PARAMETERS

INPUT/OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY (VCE = 10 V, IC = 50 mA)



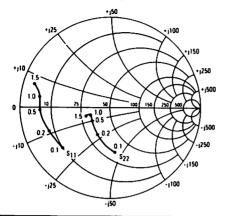
FORWARD/REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY (VCE = 10 V, IC = 50 mA)



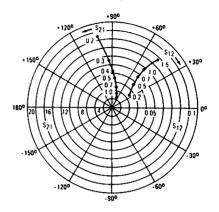
| VCE | Ic | f | S ₁ | 1 | s ₂ | 1 | S ₁ | 2 | S ₂ | 2 |
|---------|------|-------|------------------|------|-----------------|-----|----------------|------------|----------------|-------|
| (Volts) | (mA) | (MHz) | ·S ₁₁ | LO | S ₂₁ | .0 | S12! | L ø | IS221 | LØ |
| 5.0 | 10 | 100 | 0.65 | -101 | 16.61 | 125 | 0.047 | 46 | 0.61 | -56 |
| 0.0 | ' | 300 | 0.64 | -160 | 6.61 | 96 | 0.064 | 39 | 0.27 | -87 |
| | · ' | 500 | 0.66 | -178 | 4.01 | 83 | 0.078 | 45 | 0.19 | -98 |
| | | 700 | 0.68 | 171 | 2.93 | 73 | 0.093 | 49 | 0.16 | - 108 |
| | | 1000 | 0.68 | 160 | 2.07 | 63 | 0.119 | 53 | 0.16 | -124 |
| | | 1500 | 0.72 | 143 | 1.43 | 50 | 0.158 | 54 | 0.21 | -141 |
| | 25 | 100 | 0.60 | -129 | 22.41 | 115 | 0.034 | 44 | 0.49 | -84 |
| | | 300 | 0.63 | -172 | 7.94 | 93 | 0.049 | 50 | 0.26 | -132 |
| | | 500 | 0.66 | 174 | 4.78 | 83 | 0.071 | 58 | 0.21 | - 150 |
| | | 700 | 0.67 | 166 | 3.45 | 75 | 0.092 | 60 | 0.20 | -164 |
| | | 1000 | 0.67 | 156 | 2.46 | 66 | 0.124 | 61 | 0.21 | -177 |
| | | 1500 | 0.71 | 140 | 1.73 | 54 | 0.173 | 60 | 0.24 | 175 |
| | 50 | 100 | 0.59 | -147 | 25.12 | 109 | 0.025 | 46 | 0.42 | -104 |
| | | 300 | 0.64 | -178 | 8.47 | 91 | 0.046 | 60 | 0.28 | -151 |
| | ŀ | 500 | 0.67 | 171 | 5.05 | 83 | 0.070 | 65 | 0.26 | -167 |
| | ł | 700 | 0.68 | 164 | 3.67 | 75 | 0.093 | 65 | 0.25 | -178 |
| | ł | 1000 | 0.67 | 154 | 2.60 | 67 | 0.128 | 65 | 0.26 | 170 |
| | 1 | 1500 | 0.72 | 138 | 1.83 | 56 | 0.178 | 62 | 0.29 | 163 |
| 10 | 10 | 100 | 0.65 | -90 | 17.47 | 128 | 0.040 | 50 | 0.67 | -41 |
| | '' | 300 | 0.61 | -154 | 7.31 | 97 | 0.057 | 41 | 0.33 | -57 |
| | ľ | 500 | 0.62 | -174 | 4.46 | 84 | 0.069 | 46 | 0.25 | ~58 |
| | ł | 700 | 0.64 | 175 | 3.27 | 74 | 0.084 | 50 | 0.22 | -60 |
| | ļ | 1000 | 0.64 | 163 | 2.33 | 64 | 0.106 | 54 | 0.20 | -72 |
| | | 1500 | 0.69 | 145 | 1.56 | 50 | 0.140 | 57 | 0.22 | -96 |
| | 25 | 100 | 0.57 | -116 | 24.36 | 119 | 0.030 | 48 | 0.51 | -62 |
| | | 300 | 0.58 | -167 | 8.10 | 94 | 0.045 | 52 | 0.20 | -89 |
| | | 500 | 0.61 | 178 | 5.43 | 83 | 0.070 | 58 | 0.14 | -97 |
| | | 700 | 0.63 | 169 | 3.93 | 75 | 0.084 | 60 | 0.10 | -106 |
| | | 1000 | 0.62 | 159 | 2.78 | 66 | 0.112 | 61 | 0.09 | -124 |
| | ł | 1500 | 0.67 | 142 | 1.91 | 53 | 0.156 | 60 | 0.12 | -140 |
| | 50 | 100 | 0.55 | -132 | 26.97 | 112 | 0.024 | 47 | 0,40 | -73 |
| | l | 300 | 0.57 | -173 | 9.32 | 91 | 0.042 | 59 | 0.16 | -104 |
| | | 500 | 0.60 | 174 | 5.58 | 82 | 0.064 | 64 | 0.11 | -115 |
| | | 700 | 0.62 | 167 | 4.04 | 74 | 0.086 | 64 | 0.08 | -128 |
| | i | 1000 | 0.61 | 158 | 2.85 | 66 | 0.115 | 64 | 0.08 | -149 |
| | 1 | 1500 | 0.67 | 141 | 1.96 | 55 | 0.158 | 61 | 0.12 | -158 |

MRF962 COMMON-EMITTER S-PARAMETERS

INPUT/OUTPUT REFLECTION
COEFFICIENTS versus FREQUENCY
(VCE = 10 V, IC = 50 mA)



FORWARD/REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY (VCE = 10 V, IC = 50 mA)

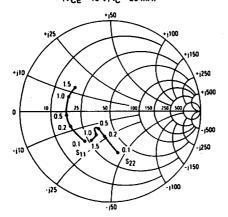


| VCE | lc | f | s | 11 | S | 21 | S | 12 | s | 22 |
|---------|------|-------|--------------------|------|-------|-----|------------------|----|-----------------|-------|
| (Volts) | (mA) | (MHz) | 1S ₁₁ 1 | LO | S21 | 40 | :S ₁₂ | 40 | S ₂₂ | Lφ |
| 5.0 | 10 | 100 | 0.70 | -102 | 17.42 | 128 | 0.044 | 43 | 0.65 | -57 |
| | | 300 | 0.75 | -156 | 7.11 | 98 | 0.058 | 24 | 0.32 | -97 |
| | | 500 | 0.78 | -170 | 4.36 | 86 | 0.064 | 25 | 0.26 | -110 |
| | | 700 | 0.78 | -176 | 3.16 | 77 | 0.071 | 26 | 0.23 | -117 |
| | | 1000 | 0.78 | 176 | 2.26 | 67 | 0.078 | 27 | 0.24 | -126 |
| | | 1500 | 0.79 | 167 | 1.51 | 54 | 0.092 | 29 | 0.31 | -133 |
| | 25 | 100 | 0.69 | -131 | 24.24 | 118 | 0.029 | 38 | 0.56 | -87 |
| | | 300 | 0.77 | -167 | 8.76 | 95 | 0.039 | 32 | 0.35 | -137 |
| | | 500 | 0.79 | -176 | 5.26 | 85 | 0.046 | 36 | 0.32 | -150 |
| | | 700 | 0.80 | 178 | 3.82 | 78 | 0.055 | 40 | 0.31 | -158 |
| | | 1000 | 0.79 | 173 | 2.72 | 70 | 0.067 | 42 | 0.32 | -164 |
| | | 1500 | 0.81 | 164 | 1.82 | 59 | 0.086 | 42 | 0.34 | -167 |
| - 1 | 50 | 100 | 0.71 | -147 | 27.72 | 113 | 0.021 | 37 | 0.53 | -107 |
| | | 300 | 0.78 | -173 | 9.59 | 94 | 0.030 | 40 | 0.41 | -152 |
| I | | 500 | 0.81 | 179 | 5.72 | 85 | 0.038 | 46 | 0.39 | -163 |
| | | 700 | 0.81 | 176 | 4.09 | 78 | 0.048 | 50 | 0.38 | -169 |
| - 1 | | 1000 | 0.81 | 171 | 2.89 | 71 | 0.061 | 51 | 0.38 | -175 |
| | | 1500 | 0.82 | 163 | 1.96 | 62 | 0.082 | 49 | 0.40 | -177 |
| 10 | 10 | 100 | 0.71 | -92 | 18.77 | 131 | 0.037 | 47 | 0.70 | -44 |
| 1 | 1 | 300 | 0.74 | -150 | 8.09 | 100 | 0.051 | 28 | 0.34 | -69 |
| | | 500 | 0.75 | -166 | 5.01 | 87 | 0.056 | 28 | 0.27 | -75 |
| | | 700 | 0.76 | -174 | 3.62 | 78 | 0.064 | 28 | 0.24 | -79 |
| | | 1000 | 0.76 | 179 | 2.58 | 69 | 0.071 | 30 | 0.24 | -88 |
| L | | 1500 | 0.77 | 168 | 1.72 | 55 | 0.085 | 31 | 0.31 | ~104 |
| | 25 | 100 | 0.67 | -120 | 27.10 | 122 | 0.027 | 42 | 0.57 | -68 |
| 1 | - 1 | 300 | 0.73 | -163 | 10.27 | 97 | 0.035 | 36 | 0.27 | -110 |
| | 1 | 500 | 0.76 | -174 | 6.21 | 86 | 0.043 | 39 | 0.22 | -124 |
| | | 700 | 0.77 | -179 | 4.48 | 78 | 0.051 | 41 | 0.20 | -132 |
| ŀ | į | 1000 | 0.77 | 175 | 3.19 | 71 | 0.062 | 43 | 0.20 | -139 |
| L | i | 1500 | 0.78 | 166 | 2.13 | 59 | 0.080 | 42 | 0.25 | -142 |
| | 50 | . 100 | 0.68 | -137 | 31.53 | 116 | 0.020 | 37 | 0.49 | -85 |
| | 1 | 300 | 0.74 | -169 | 11,17 | 95 | 0.028 | 40 | 0.27 | -131 |
| | į | 500 | 0.77 | -177 | 6.69 | 85 | 0.037 | 46 | 0.24 | -144 |
| | ļ | 700 | 0.77 | 178 | 4.82 | 78 | 0.047 | 48 | 0.23 | -152 |
| | ļ | 1000 | 0.77 | 173 | 3.42 | 71 | 0.059 | 50 | 0.23 | -158 |
| - 1 | ŀ | 1500 | 0.79 | 165 | 2.30 | 61 | 0.078 | 47 | 0.27 | - 159 |

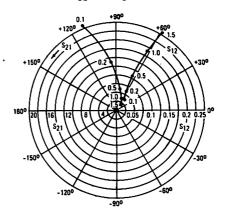
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MRF965 COMMON-EMITTER S-PARAMETERS

INPUT/OUTPUT REFLECTION
COEFFICIENTS versus FREQUENCY
(VCE = 10 V, IC = 50 mA)



FORWARD/REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY (VCE = 10 V, IC = 50 mA)



| VCE | ıc | f | S ₁ | , 1 | S ₂ | 1 | S ₁ : | 2 | S ₂ | 2 |
|---------|------|-------|-----------------|------|--------------------|-----|--------------------|----|--------------------|------|
| (Volts) | (mA) | (MHz) | S ₁₁ | LØ | IS ₂₁ : | Lφ | IS ₁₂ 1 | LΦ | IS ₂₂ I | Lφ |
| 5.0 | 10 | 100 | 0.56 | -102 | 13.87 | 121 | 0.054 | 48 | 0.58 | -62 |
| | | 300 | 0.57 | -158 | 5.47 | 90 | 0.084 | 46 | 0.32 | -94 |
| | 1 | 500 | 0.56 | -169 | 3.40 | 77 | 0.110 | 52 | 0.27 | -106 |
| | 1 | 700 | 0.52 | 178 | 2.53 | 69 | 0.136 | 54 | 0.39 | -115 |
| | l i | 1000 | 0.55 | 167 | 1.79 | 57 | 0.181 | 56 | 0.35 | -112 |
| | | 1500 | 0.54 | 150 | 1.27 | 42 | 0.242 | 57 | 0.43 | -122 |
| | 25 | 100 | 0.48 | -129 | 17.61 | 112 | 0.041 | 51 | 0.47 | -85 |
| | | . 300 | 0.55 | -169 | 6.38 | 89 | 0.076 | 57 | 0.30 | -125 |
| | | 500 | 0.54 | -176 | 3.97 | 77 | 0.111 | 62 | 0.27 | -138 |
| | | 700 | 0.50 | 172 | 2.94 | 71 | 0.114 | 61 | 0.30 | -143 |
| | l i | 1000 | 0.53 | 162 | 2.08 | 61 | 0.198 | 60 | 0.32 | -135 |
| | (I | 1500 | 0.50 | 146 | 1.50 | 47 | 0.267 | 57 | 0.37 | -140 |
| | 50 | 100 | 0.47 | -144 | 19.34 | 107 | 0.035 | 56 | 0.42 | -100 |
| | " | 300 | 0.55 | -173 | 6.72 | 87 | 0.073 | 63 | 0.31 | -138 |
| | | 500 | 0.53 | -179 | 4.17 | 77 | 0.112 | 66 | 0.29 | -150 |
| 1 | 1 1 | 700 | 0.50 | 168 | 3.10 | 71 | 0.147 | 64 | 0.33 | -153 |
| | i I | 1000 | 0.53 | 159 | 2.19 | 62 | 0.206 | 61 | 0.32 | -146 |
| | | 1500 | 0.50 | 143 | 1.59 | 49 | 0.277 | 58 | 0.36 | -149 |
| 10 | 10 | 100 | 0.56 | -92 | 14.67 | 123 | 0.047 | 50 | 0.63 | -50 |
| | 1 | 300 | 0.53 | -152 | 6.00 | 92 | 0.077 | 47 | 0.34 | -73 |
| | (| 500 | 0.53 | -165 | 3.74 | 78 | 0.100 | 53 | 0.29 | -82 |
| |] | 700 | 0.49 | -177 | 2.76 | 70 | 0.124 | 56 | 0.31 | -93 |
| | ۱ ۱ | 1000 | 0.52 | 170 | 1.96 | 57 | 0.166 | 58 | 0.38 | -94 |
| |) | 1500 | 0.51 | 153 | 1.36 | 42 | 0.221 | 59 | 0.46 | -108 |
| | 25 | 100 | 0.46 | -117 | 19.10 | 115 | 0.036 | 53 | 0.49 | -68 |
| | 1 1 | 300 | 0.50 | -164 | 7.09 | 90 | 0.071 | 57 | 0.26 | -99 |
| | 1 | 500 | 0.49 | -172 | 4.39 | 78 | 0.102 | 62 | 0.23 | -110 |
| | 1 | 700 | 0.45 | 175 | 3.25 | 71 | 0.133 | 61 | 0.25 | -119 |
| |) | 1000 | 0.49 | 164 | 2.28 | 60 | 0.181 | 61 | 0.30 | -112 |
| | | 1500 | 0.47 | 148 | 1.61 | 46 | 0.246 | 59 | 0.37 | -120 |
| | 50 | 100 | 0.42 | -131 | 20.99 | 110 | 0.033 | 56 | 0.41 | -79 |
| | | 300 | 0.49 | -169 | 7.46 | 88 | 0.069 | 62 | 0.24 | -111 |
| | | 500 | 0.48 | -175 | 4.63 | 78 | 0.103 | 65 | 0.21 | -123 |
| | | 700 | 0.45 | 172 | 3,40 | 71 | 0.136 | 64 | 0.25 | -129 |
| | | 1000 | 0.48 | 162 | 2.39 | 61 | 0.188 | 62 | 0.29 | -119 |
| | i | 1500 | 0.45 | 146 | 1.70 | 48 | 0.251 | 59 | 0.35 | -126 |

BFW92A

CASE 317A-01, STYLE 2 HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|------------|-------------|
| Collector-Emitter Voltage | VCEO | 15 | Vdc |
| Collector-Base Voltage | V _{CBO} | 25 | Vdc |
| Emitter-Base Voltage | VEBO | 2.5 | Vdc |
| Collector Current — Continuous | lc | 35 | mAdc |
| Total Device Dissipation @ T _C = 105°C Derate above 105°C | PD | 180 4.0 | mW mW/°C |
| Storage Temperature | T _{stq} | -65 to 150 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|-----|------|
| Thermal Resistance, Junction to Case(1) | R _{ØJC} | 250 | °C/W |

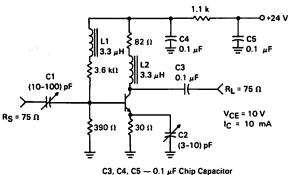
Case temperature measured on collector lead immediately adjacent to body of package.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Symbol | Min | Тур | Max | Unit |
|--------------------------------|--|--|--|---|
| | | | | |
| V(BR)CEO | 15 | _ | | Vdc |
| V(BR)CBO | 25 | _ | _ | Vdc |
| V(BR)EBO | 2.5 | - | _ | Vdc |
| ICBO | - | _ | 50 | nAdc |
| | | 1 | - | <u> </u> |
| hFE | 20 | 50 | 150 | _ |
| | | | · | ! |
| fτ | - | 4.5 | _ | GHz |
| C _{cb} | - | 0.5 | 1.0 | pF |
| | | <u> </u> | . | |
| NF _{opt} | _ | 2.7 | | dB |
| NF | _ | 3.0 | _ | dB |
| MAG | _ | 16 | | dB |
| S ₂₁ ² | _ | 14 | | dB |
| | V(BR)CBO V(BR)EBO ICBO ICBO hFE fT Ccb NFopt NF MAG | V(BR)CBO 25 V(BR)EBO 2.5 ICBO — hFE 20 fT — Ccb — NFopt — NF — MAG — | V(BR)CBO 25 — V(BR)EBO 2.5 — ICBO — — hFE 20 50 fT — 4.5 Ccb — 0.5 NFopt — 2.7 NF — 3.0 MAG — 16 | V(BR)CBO 25 — — V(BR)EBO 2.5 — — ICBO — 50 — fT — 4.5 — Ccb — 0.5 1.0 NFopt — 2.7 — NF — 3.0 — MAG — 16 — |

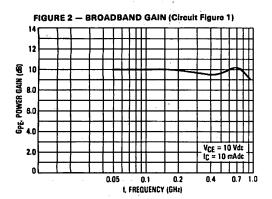
(2)
$$G_{\text{max}} = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$$

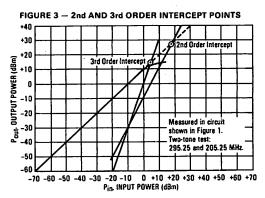
FIGURE 1 - 30-900 MHz BROADBAND AMPLIFIER

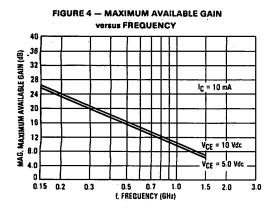


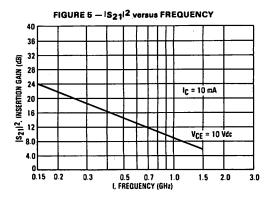
C3, C4, C5 — 0.1 μ F Chip Capacitor L1, L2 — 3.3 μ H Molded Inductor

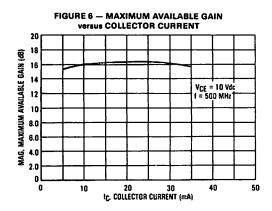
All Resistors 1/4 W, 20%



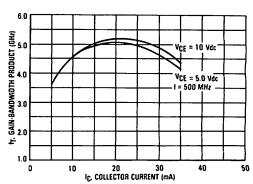


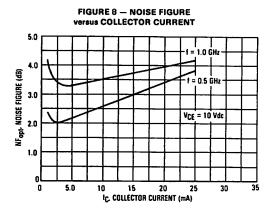


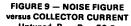


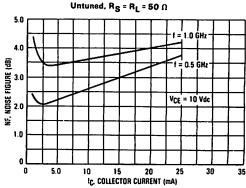












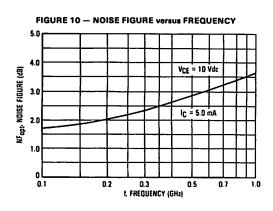
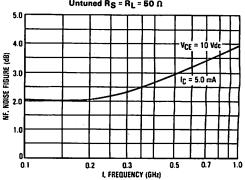
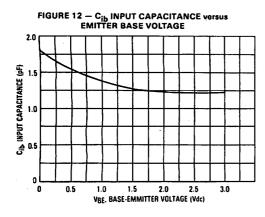
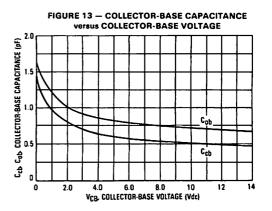


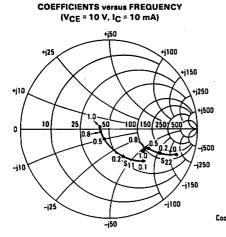
FIGURE 11 — NOISE FIGURE versus FREQUENCY
Untuned R_S = R_L = 50 Ω



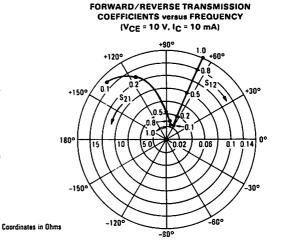




BFW92A COMMON-EMITTER S-PARAMETERS



INPUT/OUTPUT REFLECTION



BFW92A COMMON-EMITTER S-PARAMETERS

| | | | | | | | r | | | |
|---------|------|---------------------------|--------------------------------------|---------------------------|---------------------------|------------|--|----------------|--|---------------------------------|
| VCE | Ic | f ! | S₁ | 11 | s | 21 | S ₁ | 2 | s | 22 |
| (Volts) | (mA) | (MHz) | S11 | 20 | IS21 | 46 | S12 | 4 | S22 | 24 |
| 5.0 | 5.0 | 100 | 0.71 | -33 | 11.2 | 145 | 0.031 0.052 0.094 0.137 | 69 | 0.87 | -18 |
| | | 200 500 | 0.49 0.21 | -60 -119 | 8.6 4.5 | 122 | 0.052 | 62 | 0.70 | -26 |
| | | 500 | 0.21 0.17 | -119 | 3.0 | 92 78 | 0.094 | 61 60 | 0.48 | -30 -36 |
| | | 800 1000 | 0.16 | 176 | 2.5 | l % | 0.164 | 60 | 0.70 0.48 0.44 0.44 | -36 -40 |
| | 10 | 100 | 0.52 | -46 | 16.6 | 135 | 0.027 | 67 | I 070 | -23 |
| | | 200 500 | 0.31 0.14 | -75 | 16.6 11.2 5.2 | 113 | 0.027 0.044 0.089 | 65 | 0.58 | -29 |
| | | 500 | 0.14 | -150 | 5.2 | 88 | 0.089 | 67 | 0.40 | -29 |
| | | 800 1000 | 0.15 0.16 | 173 | 3.3 2.8 | 76 | 0.135 | 65 | 0.37 | -34 |
| | 15 | 100 | 0.10 | 154 -55 | 19.7 | 70 129 | 0.164 0.025 | 64 69 | 0.58 0.40 0.37 0.37 | -38 -26 |
| | '* | 200 | 0.22 | -88 | 12.1 | 109 | 0.025 | 68 | 0.72 | -20 -29 |
| | | 500 | 0.22 0.14 | -170 | 5.4 | l 86 | 0.087 | 1 70 | 0.36 | -27 |
| | İ | 200 500 800 1000 | 0.16 0.17 | -88 -170 161 145 | 12.1 5.4 3.5 2.9 | 76 | 0.041 0.087 0.134 0.164 | 68 | 0.52 0.36 0.34 0.35 | -27 -33 -37 |
| | | 1000 | 0.17 | 145 | 2.9 | 69 | 0.164 | 66 | 0.35 | -37 |
| | 20 | 100 | 0.33 0.18 | -62 | 21.1 12.5 5.5 | 125 106 | 0.023 0.039 0.086 0.133 | 69 69 | 0.68 | -27 -28 |
| | ĺ | 200 500 | 0.18 | -99 178 | 12.5 5.5 | 85 | 0.039 | 72 | 0.49 | -26 -26 |
| | 1 | 800 | 0.17 | 155 | 3.5 | 75 | 0.133 | 69 | 0.33 | -32 |
| | | 800 1000 | 0.18 | 142 | 2.9 | 69 | J 0.164 | 67 | 0.68 0.49 0.35 0.33 0.34 | -37 |
| | 25 | 100 | 0.27 | -69 | 21.9 12.7 | 122 | 0.022 | 70 | 0.65 | -27 |
| | l | 200 | 0.15 | -111 | 12.7 | 104 | 0.038 0.085 0.132 | 71 | 0.47 0.35 0.33 | -27 |
| | 1 | 500 | 0.16 | 172 153 | 5.5 3.5 | 85 75 | 0.085 | 73 70 | 0.35 | -25 -31 |
| | • | 200 500 800 1000 | 0.15 0.16 0.19 0.20 | 140 | 2.9 | 69 | 1 0 163 | 68 | | -36 |
| 10 | 5.0 | 100 200 500 | 0.73 0.53 | -30 -52 | 11.1 | 146 | 0.026 0.044 0.082 0.120 0.143 | 71 | 0.90 0.75 0.57 0.53 0.53 | -14 |
| | | 200 | 0.53 | -52 | 8.8 | 124 | 0.044 | 63 | 0.75 | -21 |
| | | 500 | 0.21 | -98 | 4.7 | 94 | 0.082 | 62 | 0.57 | -25 |
| | | 800 1000 | 0.14 0.11 | -136 -161 | 3.1 2.6 | 80 73 | 0.120 | 62 62 | 0.53 | -30 -34 |
| | 10 | 100 | 0.11 | -39 | 16.7 | 137 | 0.143 | 70 | 0.53 | -34 -18 |
| | | 100 200 | 0.35 | -62 | 11.5 | 115 | 0.023 | 66 | 0.62 | -23 |
| | | 500 | 0.12 | -117 | 5.4 | 89 | 0.078 | 69 | 0.50 | -23 |
| | | 800 1000 | 0.57 0.35 0.12 0.09 0.09 | -163 | 3.5 | 78 | 0.023 0.038 0.078 0.118 | 67 | 0.47 | -28 -32 |
| | 15 | 1000 | 0.09 | 168 | 2.9 | 71 | 0.144 | 66 | 0.82 0.65 0.50 0.47 0.48 0.77 0.60 0.47 0.45 0.46 | -32 |
| | 15 | 100 200 | 0.46 0.26 | -46 -68 | 19.9 12.6 | 130 110 | 0.021 | 70 68 | 0.77 | -20 |
| | | 500 | 0.09 | -137 | 5.6 | 87 | 0.035 | 71 | 0.60 | -22 |
| | 1 | 800 1000 | 0.09 | 177 | 3.7 | 77 | 0.117 | 69 | 0.45 | -27 |
| | | 1000 | 0.10 | 153 | 3.0 | 71 | 0.144 0.021 0.035 0.076 0.117 0.143 | 69 68 | 0.46 | -22 -21 -27 -31 |
| [| 20 | 100 | 0.39 0.21 0.08 0.10 | -50 | 21.5 13.0 | 126 | 0.020 | 70 | 0.74 0.58 | -21 |
| j | | 200 | 0.21 | -73 -154 | 13.0 | 107 86 | 0.034 | 71 72 | 0.58 | -21 |
| i | | 500 800 | 0.08 | 168 | 5.7 3.7 | 76 | 0.075 | 70 | 0.46 0.45 | -20 -27 |
| 1 | | 1000 | 0.11 | 148 | 3.0 | 71 | 0.020 0.034 0.075 0.117 0.142 | 69 | 0.45 | -21 -21 -20 -27 -31 |
| 1 | 25 | 100 | 0.34 0.17 | -54 | 22.3 | 123 | 0.019 0.033 0.075 0.116 0.141 | 70 | 0.71 0.57 0.47 0.45 0.46 | -20 |
| ļ | | 200 | 0.17 | -79 | 13.0 | 105 | 0.033 | 71 | 0.57 | -20 -19 |
| | | 500 | 0.08 0.11 | -166 | 5.7 | 86 | 0.075 | 73 | 0.47 | -19 |
| l | | 800 1000 | 0.11 | 162 144 | 3.7 3.0 | 76 70 | 0.116 | 73 70 69 | 0.45 | -26 -30 |
| | | '~~ | 0.13 | 144 | 3.0 | ,0 | 0.141 | 05 | 0.40 | -30 |
| | | | | | | | | | لسيسا | |

BFX89 **BFY90**

CASE 20-03. STYLE 10 TO-72 (TO-206AF)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|-------------|
| Collector-Emitter Voltage | VCEO | 15 | Vdc |
| Collector-Base Voltage | VCBO | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 2.5 | Vdc |
| Collector Current — Continuous | lc | 50 | mAdc |
| Total Continuous Device Dissipation @ TA = 25°C Derate above 25°C | PD | 200 1.14 | mW mW/°C |
| Storage Temperature | T _{stg} | -65 to +200 | °C |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

Symbol Min Тур Max Unit Characteristic OFF CHARACTERISTICS 15 Vdc Collector-Emitter Breakdown Voltage V(BR)CEO (IC = 10 mAdc, IB = 0) 10 nAdc Collector Cutoff Current ІСВО

(VCB = 15 Vdc, IE = 0) ON CHARACTERISTICS

| DC Current Gain | hFE | i I | | l | - |
|--------------------------------|-----|-----|---|-----|-----|
| (IC = 2.0 mAdc, VCE = 1.0 Vdc) | | 25 | _ | 150 | l |
| (IC = 25 mAdc, VCE = 1.0 Vdc) | l | 20 | | 125 | L., |

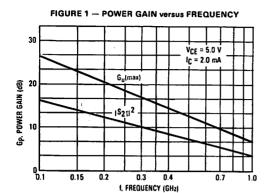
SMALL SIGNAL CHARACTERISTICS

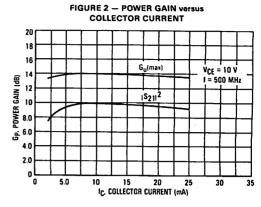
| SWALL SIGNAL CHARACTERISTICS | | fT | | | | GHz |
|--|-------|-----------------|-----|--------------|-----|-----|
| Current-Gain — Bandwidth Product(1) | BFX89 | '' | l _ | 1.0 | _ | |
| (IC = 2.0 mA, VCE = 5.0 Vdc, f = 500 MHz) | BFY90 | | 1.0 | | - | |
| (IC = 25 mA, VCE = 5.0 Vdc, f = 500 MHz) | BFX89 | | _ | 1.1 | _ | |
| | BFY90 | | 1.3 | | _ | |
| Emitter-Base Capacitance (VEB = 0.5 Vdc, I _C = 0, f = 1.0 MHz) | BFY90 | Cibo | - | - | 2.0 | pF |
| Collector-Base Capacitance(2) | | C _{cb} | | | | pF |
| (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | BFX89 | 1 - | 1 – | 0.85 | 1.7 | |
| 1100 | BFY90 | 1 | l — | 0.85 | 1.5 | |

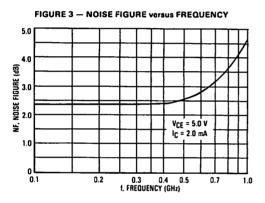
FUNCTIONAL TEST

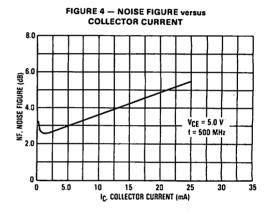
| Common-Emitter Amplifier Power Gain(1) (VCE = 10 Vdc, IC = 8.0 mA, f = 200 MHz) | BFX89 BFY90 | Gpe | 19 — | 21 | - | dΒ |
|--|----------------|-----|---------|------------|------------|----|
| Spot Noise Figure (Rs = Optimum)(1) (VCE = 5.0 Vdc, I _C = 2.0 mA, f = 500 MHz) | BFX89 BFY90 | NF | _ | 2.5 2.5 | 6.5 5.0 | d₿ |

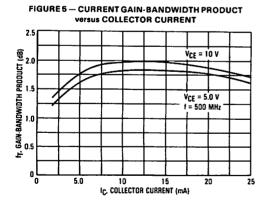
⁽¹⁾ Pin 4 is grounded. (2) Pin 4 is not grounded.

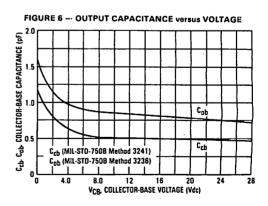








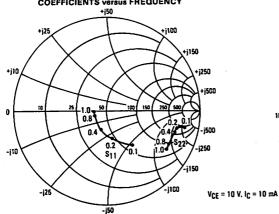


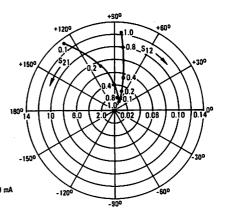


COMMON EMITTER SCATTERING PARAMETERS

FIGURE 7 — INPUT AND OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY

FIGURE 8 — FORWARD AND REVERSE TRANSMISSION COEFFICIENTS Versus FREQUENCY





Coordinates in Chms

S - PARAMETERS

| VCE | lc | Frequency | S- | 11 | S ₂₁ | | S ₁ | 2 | S ₂ | 2 |
|----------|--------------|-----------|-----------------|------|-----------------|------------|-----------------|-----------|-----------------|-----|
| (Volts) | (mA) | (MHz) | S ₁₁ | Lφ | S ₂₁ | Δ φ | S ₁₂ | - | S ₂₂ | Zφ |
| 5.0 | 2.0 | 100 | 0.81 | -37 | 5.76 | 148 | 0.031 | 72 | 0.95 | -11 |
| " "." | | 200 | 0.64 | -66 | 4.56 | 127 | 0.050 | 63 | 0.87 | -17 |
| ł i | ! ! | 400 | 0.41 | -105 | 2.91 | 102 | 0.071 | 62 | 0.79 | -23 |
| | 1 | 800 | 0.26 | -157 | 1.63 | 77 | 0.105 | 74 | 0.75 | -34 |
| | | 1000 | 0.23 | 179 | 1.38 | 68 | 0.129 | 80 | 0.74 | -41 |
| | 5.0 | 100 | 0.60 | -54 | 9.73 | 133 | 0.026 | 68 | 0.87 | -13 |
| l i | | 200 | 0.41 | -84 | 6.33 | 112 | 0.040 | 66 | 0.78 | -17 |
| | 1 | 400 | 0.26 | -121 | 3.54 | 92 | 0.064 | 72 | 0.73 | -21 |
| 1 | | 800 | 0.19 | -169 | 1.89 | 72 | 0.112 | 80 | 0.72 | -31 |
| 1 | <u> </u> | 1000 | 0.17 | 168_ | 1.59 | 64 | 0.140 | 82 | 0.71 | -39 |
| | 10 | 100 | 0.71 | -66 | 12.13 | 122 | 0.022 | 70 | 0.81 | -14 |
| | 1 | 200 | 0.28 | -96 | 7.11 | 104 | 0.036 | 71 | 0.73 | -15 |
| | 1 1 | 400 | 0.19 | -133 | 3.85 | 88 | 0.064 | 77 | 0.70 | -19 |
| | 1 1 | 800 | 0.18 | -178 | 2.00 | 69 | 0.115 | 83 | 0.71 | -30 |
| 1 | l i | 1000 | 0.17 | 160 | 1.66 | 61 | 0.143 | 84 | 0.70 | -37 |
| . | 25 | 100 | 0.26 | -88 | 12.79 | 112 | 0.019 | 73 | 0.76 | -13 |
| 1 | 1 | 200 | 0.20 | -122 | 7.04 | 97 | 0.034 | 76 | 0.71 | -13 |
| ł | l i | . 400 | 0.20 | -156 | 3.68 | 83 | 0.062 | 81 | 0.70 | -18 |
| 1 | ł l | 800 | 0.23 | 165 | 1.88 | 65 | 0.114 | . 86 | 0.71 | -30 |
| ķ | 1 1 | 1000 | 0.24 | 146 | 1.56 | 58 | 0.145 | 88 | 0.70 | -38 |
| 10 | 2.0 | 100 | 0.83 | -34 | 5.82 | 150 | 0.025 | 73 | 0.96 | -9 |
| , | 1 1 | 200 | 0.66 | -61 | 4.60 | 129 | 0.042 | 65 | 0.89 | -15 |
| ì | 1 | 400 | 0.42 | -97 | 2.98 | 104 | 0.059 | 64 | 0.83 | -20 |
| l | i 1 | 800 | 0.25 | -147 | 1.69 | 79 | 0.088 | 77 | 0.80 | -31 |
| | 11 | 1000 | 0.20 | -172 | 1.42 | 70 | 0.108 | 82 | 0.79 | -38 |
| ľ | 5.0 | 100 | 0.63 | -48 | 9.94 | 135 | 0.021 | 70 | 0.90 | |
| ł | 1 1 | 200 | 0.43 | -76 | 6.54 | 114 | 0.034 | 68 | 0.82 | -15 |
| | 1 1 | 400 | 0.26 | -108 | 3.72 | 94 | 0.054 | 73 | 0.77 | -19 |
| l . | 1 1 | 800 | 0.16 | -155 | 1.98 | 74 | 0.095 | 83 | 0.77 | -24 |
| ì | oxdot | 1000 | 0.14 | 180 | 1.65 | 66 | 0.119 | 85 | 0.76 | -36 |
| | 10 | 100 | 0.47 | -57 | 12.42 | 125 | 0.019 | 70 | 0.85 | -12 |
| 1 | <u>l</u> ' l | 200 | 0.30 | -83 | . 7.43 | 106 | 0.031 | 72 | 0.78 | -14 |
| | 1] | 400 | 0.19 | -113 | 4.04 | 90 | 0.054 | 78 | 0.75 | -18 |
| İ | 1 1 | 800 | 0.14 | -160 | 2.09 | 71 | 0.098 | 84 | 0.75 | -28 |
| 1 | | 1000 | 0.13 | 173 | 1.73 | 64 | 0.121 | 86 | 0.75 | -35 |
| 1 | 25 | 100 | 0.32 | -71 | 13.05 | 114 | 0.017 | 72 | 0.81 | -11 |
| i | | 200 | 0.21 | -99 | 7.27 | 99 | 0.029 | 76 | 0.77 | -12 |
| 1 | 1 1 | 400 | 0.16 | -135 | 3.81 | 85 | 0.052 | 81 | 0.76 | -16 |
| | | 800 | 0.17 | 177 | 1.96 | 68 | 0.096 | 87 | 0.76 | -28 |
| | 1 1 | 1000 | 0.18 | 154 | 1.62 | 61 | 0.120 | 89 | 0.76 | -35 |

MD4957

CASE 654-02, STYLE 1 TO-78

DUAL HIGH FREQUENCY TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| III OUI IOCI III O | | | | | | |
|--|----------------------|-------------|------------|-------------|--|-----|
| Rating | Symbol | Va | Unit | | | |
| Collector-Emitter Voltage | VCEO | 30 | | 30 | | Vdc |
| Collector-Base Voltage | VCBO | 30 | | 30 | | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | | Vdc | | |
| Collector Current | lc | : | mAdc | | | |
| | | One Side | Both Sides | | | |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 200 1.15 | 400 2.3 | mW mW/°C | | |
| Operating and Storage Junction Temperature Range | TJ, T _{stg} | -65 to +200 | | ౡ | | |

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|-------------------|------|------------|-----|---------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, Ig = 0) | V(BR)CEO | 30 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 30 | | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 µAdc, I _C = 0) | V(BR)EBO | 3.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 20 Vdc, IE = 0) | ICBO | - | _ | 0.1 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 2.0 mAdc, VCE = 10 Vdc) | hFE | 20 | | 150 | _ |
| SMALL SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 2.0 mAdc, VCE = 10 Vdc, f = 100 MHz) | fT | 1000 | 1500 | _ | MHz |
| Collector-Base Capacitance (VCB = 10 Vdc, I _E = 0, f = 100 kHz) | C _{cb} | _ | 0.4 | 0.8 | pF |
| Small Signal Current Gain (IC = 2.0 mAdc, VCE = 10 Vdc, f = 1.0 kHz) | hfe | 20 | _ | 200 | _ |
| Collector Base Time Constant (Ig = 2.0 mAdc, VCB = 10 Vdc, f = 63.6 MHz) | rb'C ^C | _ | 4.0 | 8.0 | ps |
| Noise Figure (IC = 2.0 mAdc, VCE = 10 Vdc, f = 450 MHz) (Figure 1) (IC = 2.0 mAdc, VCE = 10 Vdc, RS = 50 ohms, f = 1.0 GHz) | NF | _ | 2.6 5.0 | = | dΒ |
| FUNCTIONAL TEST | | | | | |
| Common-Emitter Amplifier Power Gain (VCE = 10 Vdc, IC = 2.0 mAdc, f = 450 MHz) (Figure 1) (VCE = 10 Vdc, IC = 2.0 mAdc, RS = 50 ohms, f = 1.0 GHz) | Gpe | = | 18 13 | _ | dΒ |



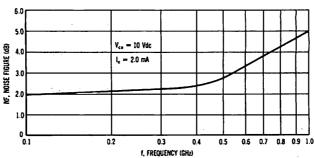
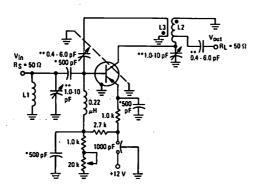


FIGURE 1 - NOISE FIGURE AND POWER GAIN TEST CIRCUIT

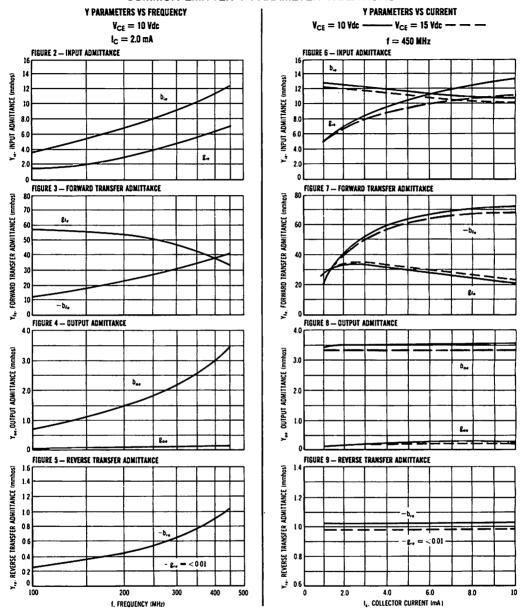


- * Button type capacitors
 ** Variable air piston type capacitors

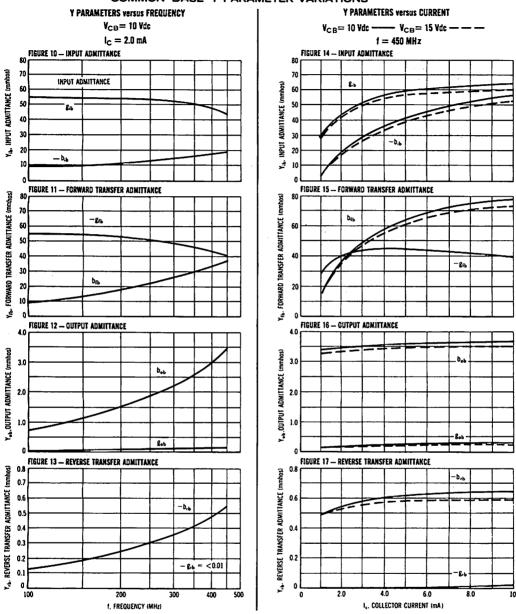
- 1. L1 silver plated brass bar; 1.0 in. Ig by 0.25 in od.
 2. L2 silver plated brass bar; 1.5 in. Ig by 0.25 in od. Tep in 0.25 in. from collector
 3. L3 % turn of AWG No. 16 wire 0.25 in. from and perallel to
- U.25 in. from and parallel to t.2.

 4. The noise source is a hot-cold body (All type 70 or equivalent) with a test receiver (All type 136 or equivalent).

COMMON EMITTER Y PARAMETER VARIATIONS



COMMON BASE Y PARAMETER VARIATIONS



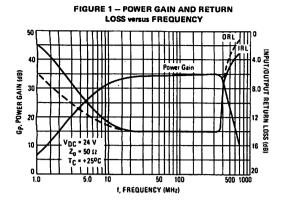
CASE 714-02
WIDEBAND HYBRID AMPLIFIER

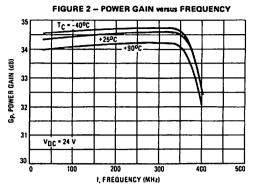
MAXIMUM RATINGS

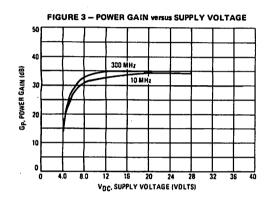
| Rating | Symbol Value | | Unit | | | | |
|----------------------------------|------------------|-------------|------------|--|--|--|--|
| Supply Voltage | VDC | 28 | Vdc | | | | |
| Input Power | Pin | 5.0 | dBm | | | | |
| Operating Case Temperature Range | TC | -20 to +90 | ° C | | | | |
| Storage Temperature Range | T _{sta} | -40 to +100 | °C | | | | |

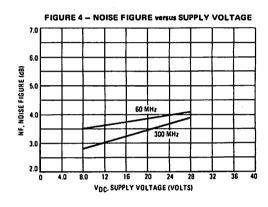
ELECTRICAL CHARACTERISTICS (V_{DC} = 24 Vdc, Z_o = 50 Ω, T_C = 25°C. All characteristics guaranteed over bandwidth listed under "Frequency Range," unless specified otherwise.)

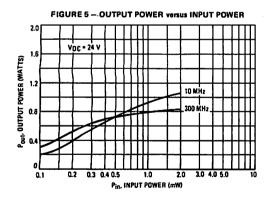
| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|-----------------|-------------|-------------------|---------|------|
| Frequency Range | BW | 10 | _ | 400 | MHz |
| Power Gain | Gp | 31.5 | 34 | 35.5 | dB |
| Gain Flatness | F | _ | | ± 1.5 | dB |
| Voltage Standing Wave Ratio, In/Out (f = 10-300 MHz) (f = 300-400 MHz) | VSWR | = | 1.5:1 2:1 | - | _ |
| 1 dB Compression (f = 10 MHz) (f = 200 MHz) (f = 400 MHz) | P1 | 700 | 800 800 300 | - | mW |
| Reverse Isolation | PRI | 43 | 50 | - | dB |
| 2nd Harmonic (Pout = 10 mW) | d _{SO} | _ | -66 | _ | dB |
| Third Order Intercept | lто | _ | 43 | - | dBm |
| Peak Envelope Power for -32 dB Distortion | PEP | _ | 500 | _ | mW |
| Noise Figure (f = 60 MHz) (f = 300 MHz) | NF | _ | 4.0 3.5 | 5.5 | dB |
| DC Voltage | V _{DC} | _ | 24 | 28 | ٧ |
| DC Current | IDC | _ | 300 | 340 | mA |











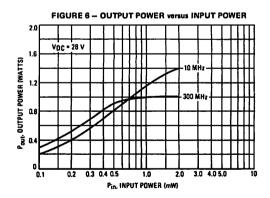


FIGURE 7 - INTERMODULATION DISTORTION - THIRD ORDER VEISUS OUTPUT POWER

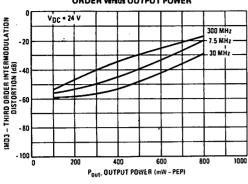


FIGURE 8 – INTERMODULATION DISTORTION – FIFTH
ORDER versus OUTPUT POWER

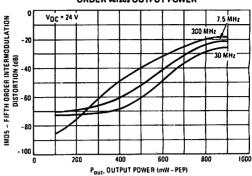


FIGURE 9 – INTERMODULATION DISTORTION – THIRD ORDER versus OUTPUT POWER

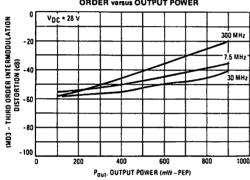


FIGURE 10 – INTERMODULATION DISTORTION – FIFTH ORDER versus OUTPUT POWER

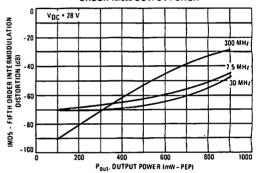
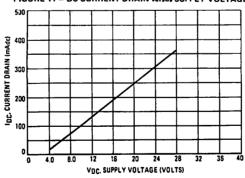


FIGURE 11 - DC CURRENT DRAIN versus SUPPLY VOLTAGE



CASE 714-02
WIDEBAND HYBRID AMPLIFIER

MAXIMUM RATINGS

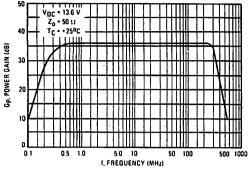
| *************************************** | | | |
|---|-----------------------|-------------|------|
| Rating | Itage V _{DC} | | Unit |
| Supply Voltage | VDC | 16 | Vdc |
| Input Power | Pin | 3.0 | dBm |
| Operating Case Temperature Range | TC | -20 to +90 | °C |
| Storage Temperature Range | T _{sta} | -40 to +100 | °C |

ELECTRICAL CHARACTERISTICS ($V_{DC}=13.6~Vdc,~Z_{O}=50~\Omega,~T_{C}=25^{\circ}C$. All characteristics guaranteed over bandwidth listed under "Frequency Range," unless specified otherwise.)

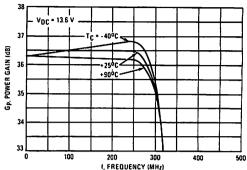
| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|-----------------|---------------|-------------------|---------------|------|
| Frequency Range | BW | 1.0 | _ | 250 | MHz |
| Power Gain | Gp | 34.5 | 36.5 | 38 | dB |
| Gain Flatness | F | _ | _ | ± 1.5 | ďВ |
| Voltage Standing Wave Ratio, In/Out (f = 1.0-30 MHz) (f = 30-250 MHz) | VSWR | | 1.5:1 2:1 | | - |
| 1 dB Compression (f = 30 MHz) (f = 100 MHz) (f = 250 MHz) | P1 | 650 — — | 800 700 250 | = | mW |
| Peak Envelope Power (IMD3 = -30 dB, f = 30 MHz) (IMD3 = -30 dB, f = 100 MHz) (IMD3 = -30 dB, f = 250 MHz) | PEP | 700 — — | 850 600 300 | = | mW |
| Noise Figure (f = 30 MHz) (f = 100 MHz) (f = 250 MHz) | NF | = | 3.7 3.7 4.5 | 5.0 — — | dB |
| DC Voltage | V _{DC} | | 13.6 | 16 | V |
| DC Current | lDC | _ | 300 | 340 | mA |

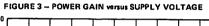


FIGURE 1 - POWER GAIN WORSUS FREQUENCY









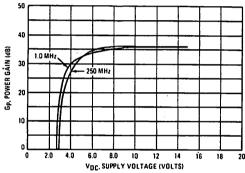


FIGURE 4 - NOISE FIGURE versus SUPPLY VOLTAGE

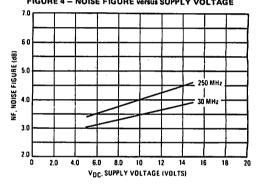


FIGURE 5 - OUTPUT POWER versus INPUT POWER

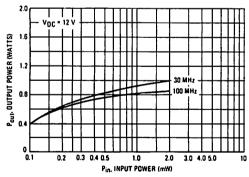
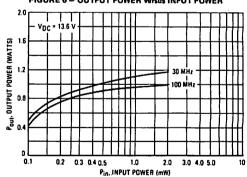
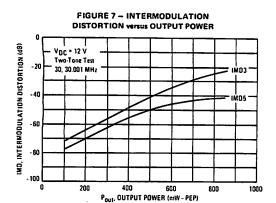
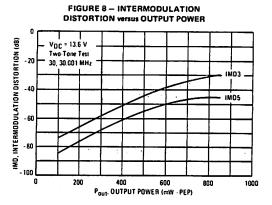
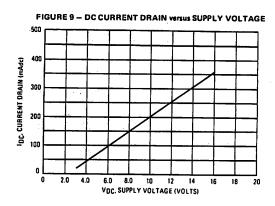


FIGURE 6 - OUTPUT POWER versus INPUT POWER









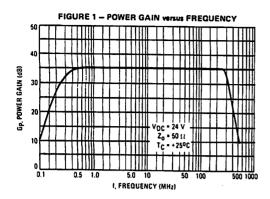
CASE 714-02
WIDEBAND HYBRID AMPLIFIER

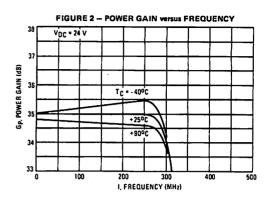
MAXIMUM RATINGS

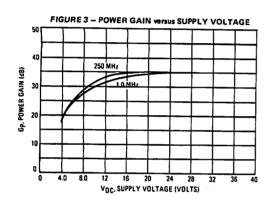
| MAXIMUM MATINGS | | | |
|----------------------------------|------------------|-------------|------|
| Rating | Symbol | Value | Unit |
| Supply Voltage | VDC | 28 | Vdc |
| Input Power | Pin | 5.0 | dBm |
| Operating Case Temperature Range | TC | -20 to +90 | °C |
| Storage Temperature Range | T _{stg} | -40 to +100 | °C |

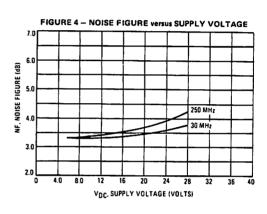
ELECTRICAL CHARACTERISTICS (V_{DC} = 24 Vdc, Z_O = 50 Ω, T_C = 25°C. All characteristics guaranteed over bandwidth listed under "Frequency Range," unless specified otherwise.)

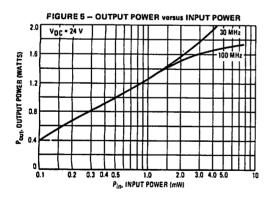
| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|-----------------|---------------|-------------------|---------------|------|
| Frequency Range | BW | 1.0 | _ | 250 | MHz |
| Power Gain | Gp | 33.5 | 35 | 36.5 | dB |
| Gain Flatness | F | | _ | ± 1.0 | dB |
| Voltage Standing Wave Ratio, In/Out (f = 1.0-30 MHz) (f = 30-250 MHz) | VSWR | _ | 1.5:1 2:1 | _ | |
| 1 dB Compression (f = 30 MHz) (f = 100 MHz) (f = 250 MHz) | P1 | 750 — — | 900 900 750 | _ _ _ | mW |
| Peak Envelope Power (IMD3 = -30 dB, f = 30 MHz) (IMD3 = -30 dB, f = 100 MHz) (IMD3 = -30 dB, f = 250 MHz) | PEP | 700 — — | 850 850 600 | _ _ _ | mW |
| Noise Figure (f = 30 MHz) (f = 100 MHz) (f = 250 MHz) | NF | _ | 3.6 3.7 3.9 | 5.0 — — | dB |
| DC Voltage | V _{DC} | <u> </u> | 24 | 28 | V |
| DC Current | lDC | _ | 300 | 340 | mA |











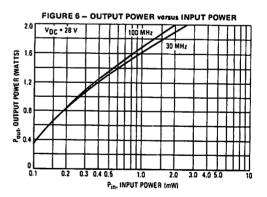


FIGURE 7 — INTERMODULATION DISTORTION versus OUTPUT POWER

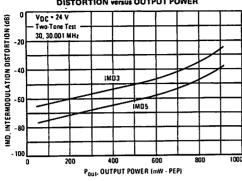


FIGURE 8 - INTERMODULATION

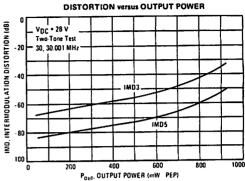
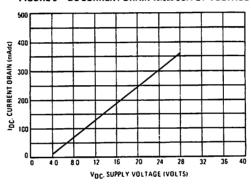


FIGURE 9 - DC CURRENT DRAIN versus SUPPLY VOLTAGE



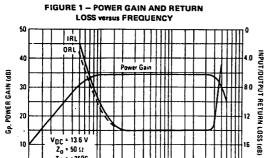
CASE 714-02
WIDEBAND HYBRID AMPLIFIER

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit | |
|----------------------------------|------------------|-------------|------|--|
| Supply Voltage | V _{DC} | 16 | Vdc | |
| Input Power | Pin | 3.0 | dBm | |
| Operating Case Temperature Range | ΤC | -20 to +90 | °C | |
| Storage Temperature Range | T _{sta} | -40 to +100 | ℃ | |

ELECTRICAL CHARACTERISTICS (V_{DC} = 13.6 Vdc, Z_O = 50 Ω, T_C = 25°C. All characteristics guaranteed over bandwidth listed under "Frequency Range," unless specified otherwise.)

Max Unit Symbol Min Тур Characteristic 400 MHz BW 10 Frequency Range dB 33 34.5 36 Gp Power Gain ± 1.0 dΒ **Gain Flatness VSWR** Voltage Standing Wave Ratio, In/Out (f = 10-300 MHz) 1.5:1 (f = 300-400 MHz)2:1 P1 mW 1 dB Compression (f = 10 MHz) 600 500 600 (f = 200 MHz)(f = 400 MHz) 200 45 ďΒ PRI 50 Reverse Isolation - 55 dΒ dso 2nd Harmonic (P_{out} = 10 mW) dBm 38 Third Order Intercept ITO PEP 300 mW Peak Envelope Power for -32 dB Distortion dB NF **Noise Figure** (f = 60 MHz) 3.7 4.0 5.5 (f = 300 MHz) V_{DC} 13.6 16 ٧ DC Voltage 300 340 mΑ IDC **DC Current**



50 100

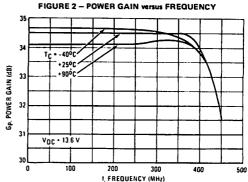
I, FREQUENCY (MHz)

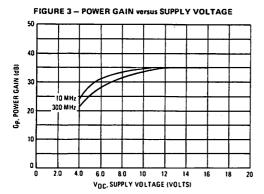
500 1000

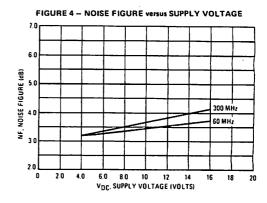
TC = +25°C

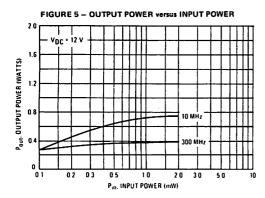
5.0 10

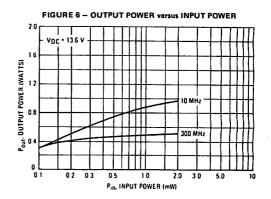
1.0











MHW593

FIGURE 7 — INTERMODULATION DISTORTION — THIRD ORDER versus OUTPUT POWER

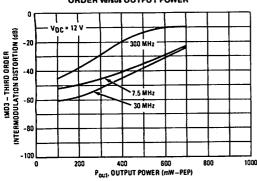


FIGURE 8 — INTERMODULATION DISTORTION — FIFTH ORDER VERSUS OUTPUT POWER

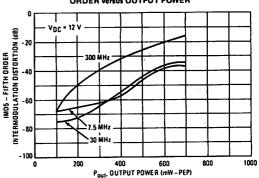


FIGURE 9 — INTERMODULATION DISTORTION — THIRD ORDER versus OUTPUT POWER

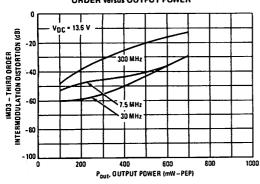


FIGURE 10 – INTERMODULATION DISTORTION ~ FIFTH
ORDER versus OUTPUT POWER

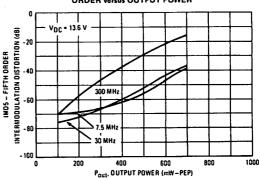
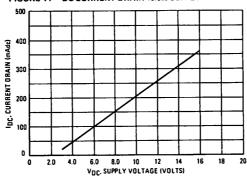


FIGURE 11 - DC CURRENT DRAIN versus SUPPLY VOLTAGE



MM4018

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

HIGH FREQUENCY TRANSISTOR

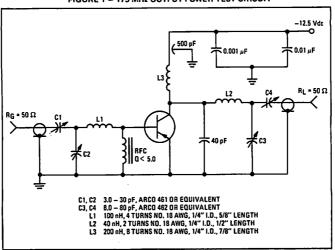
PNP SILICON

MAXIMUM RATINGS

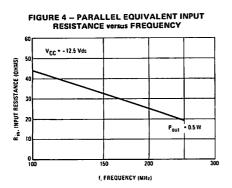
| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Base Voltage | V _{CBO} | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | IC | 0.4 | Adc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

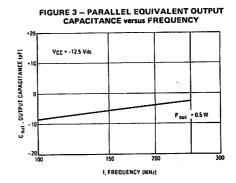
| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|------------------|-----|-----|-----|------|
| OFF CHARACTERISTICS | | | | 1 | |
| Collector-Emitter Breakdown Voltage (I _C = 5.0 mAdc, I _B = 0) | V(BR)CEO | 20 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 5.0 mAdc, I _E = 0) | V(BR)CBO | 40 | | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 1.0 mAdc, I _C = 0) | V(BR)EBO | 4.0 | _ | - | Vdc |
| Collector Cutoff Current (VCE = 15 Vdc, IB = 0) | ICEO | _ | _ | 20 | μAdc |
| Collector Cutoff Current (VCB = 15 Vdc, I _E = 0) | ICBO | _ | _ | 10 | μAdc |
| Collector Cutoff Current (VCE = 40 Vdc, VBE = 0) | ICES | - | _ | 0.1 | mAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 50 mAdc, V _{CE} = 5.0 Vdc) | pkE | 10 | _ | _ | _ |
| SMALL SIGNAL CHARACTERISTICS | | · | · | | |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 15 Vdc, f = 100 MHz) | fT | _ | 900 | - | MHz |
| Output Capacitance (VCB = 12.5 Vdc, IE = 0, f = 100 kHz) | C _{obo} | _ | 3.5 | - | pF |
| FUNCTIONAL TEST | | | | | |
| Power Output (Figure 1) (Pin = 50 mW, V _{CC} = 12.5 Vdc, f = 175 MHz) | Pout | 0.5 | _ | _ | Watt |
| Collector Efficiency (Figure 1) (Pin = 50 mW, V _{CC} = 12.5 Vdc, f = 175 MHz) | η | 45 | 55 | 1 | % |

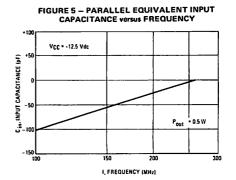
FIGURE 1 - 175 MHz OUTPUT POWER TEST CIRCUIT



Pin . POWER INPUT (mly)







MM4019

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

HIGH FREQUENCY TRANSISTOR

PNP SILICON

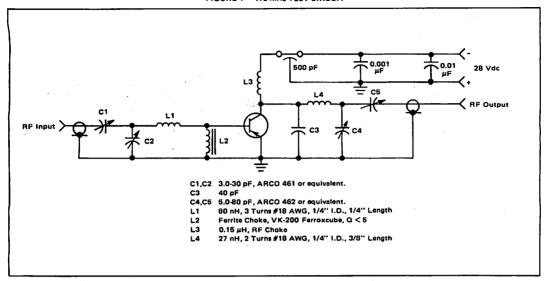
MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 40 | Vdc |
| Collector-Base Voltage | VCBO | 60 | Vdc |
| Emitter-Base Voltage | V _{EBO} | 4.0 | Vdc |
| Collector Current — Continuous | lc | 1.0 | Adc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

Refer to 2N5160 for graphs.

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|----------------------|-----|-----|------|-------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 10 mAdc, IB = 0) | V _{(BR)CEO} | 40 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 10 mAdc, IE = 0) | V _{(BR)CBO} | 60 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 0.1 Adc, IC = 0) | V _{(BR)EBO} | 4.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCE = 30 Vdc, IB = 0) | ICEO | _ | _ | 0.1 | mAdc |
| Emitter Cutoff Current (VBE = 4.0 Vdc, IC = 0) | †EBO | _ | _ | 0.1 | mAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 250 mAdc, V _{CE} = 5.0 Vdc) | hFE | 10 | _ | | _ |
| Collector-Emitter Saturation Voltage (I _C = 250 mAdc, I _B = 50 mAdc) | VCE(sat) | - | _ | 1.0 | Vdc |
| SMALL SIGNAL CHARACTERISTICS | | _ | | | |
| Current-Gain — Bandwidth Product (IC = 100 mAdc, V _{CE} = 28 Vdc, f = 100 MHz) | ĺΤ | _ | 750 | _ | MHz |
| Output Capacitance (VCB = 30 Vdc, IE = 0, f = 100 kHz) | C _{obo} | _ | 7.5 | _ | pF |
| FUNCTIONAL TEST | | | | | |
| Power Output (Pin = 0.5 W, VCC = 28 Vdc, f = 400 MHz) | Pout | _ | 2.0 | _ | Watts |
| Collector Efficiency (Pout = 2.5 W, VCC = 28 Vdc, f = 175 MHz) | η | 50 | | _ | % |
| Power Input (P _{out} = 2.5 W, V _{CC} = 28 Vdc, f = 175 MHz) | Pin | _ | _ | 0.25 | Watt |

FIGURE 1 - 175 MHz TEST CIRCUIT



MM4049 MRF534 MRF536

MRF534 CASE 22-03, STYLE 1 TO-206AA

MRF536 CASE 317-01, STYLE 2

MM4049 CASE 20-03, STYLE 2 TO-206AF

HIGH FREQUENCY TRANSISTOR

PNP SILICON

| MAXIMUM RATINGS | MM4049 Case 20-03 TO-206AF | MRF534 Case 22-03 TO-206AA | MRF536 Case 317-01 Macro-X | | |
|--|-----------------------------------|----------------------------------|----------------------------------|-------------|-------------|
| Collector-Emitter Voltage | VCEO | 10 | 10 | 10 | Vdc |
| Collector-Base Voltage | VCBO | 15 | 15 | 15 | Vdc |
| Emitter-Base Voltage | VEBO | 4.5 | 4.5 | 4.5 | Vdc |
| Collector Current — Continuous | lc | 30 | 30 | 30 | mAdc |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 200 1.14 | 300 1.71 | 300 2.40 | mW mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | -65 to +200 | -65 to +150 | ౮ |

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|--------------------|-------------------|----------------|----------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 2.0 mAdc, Ig = 0) | V(BR)CEO | 10 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 μAdc, IE = 0) | V(BR)CBO | 15 | | _ | Vdc |
| (I _E = 100 μAdc, I _C = 0) | V(BR)EBO | 4.5 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 10 Vdc, I _E = 0) | ІСВО | _ | _ | 10 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 25 mAdc, VCE = 2.0 Vdc) | hFE | 20 | _ | 200 | _ |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 20 mAdc, VCE = 5.0 Vdc, f = 500 MHz) MRF MRF | 534, MM4049 536 | 4.0 5.0 | = | _ | GHz |
| Collector-Base Capacitance (VCB = 5.0 Vdc, I _E = 0, f = 1.0 MHz) | C _{cb} | _ | - | 1.3 | pF |
| FUNCTIONAL TEST | | | | | |
| Maximum Available Gain (I _C = 15 mAdc, V _{CE} = 5.0 Vdc, f = 500 MHz) MRF (I _C = 15 mAdc, V _{CE} = 5.0 Vdc, f = 500 MHz) MM4 (I _C = 15 mAdc, V _{CE} = 5.0 Vdc, f = 1.0 GHz) MRF | 1049 | 10 11.5 8.5 | 12 13 10 | <u>-</u> | dB |

MM4049 • MRF534 • MRF536

FIGURE 1 — CURRENT GAIN — BANDWIDTH PRODUCT versus CURRENT

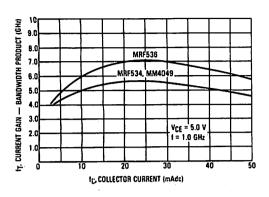


FIGURE 2 — MAXIMUM AVAILABLE GAIN versus COLLECTOR CURRENT

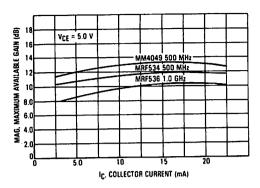
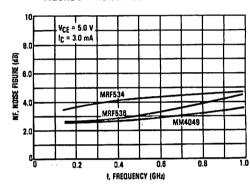


FIGURE 3 - NOISE FIGURE versus FREQUENCY



MM4049 • MRF534 • MRF536

MM4049 COMMON-EMITTER S-PARAMETERS

| VCE | lc | ſ | S | 11 | s | 21 | s | 12 | s | 22 |
|---------|------|-------|--------|-----|-----------------|------------|--------------------|------------|--------------------|-----|
| (Voits) | (mA) | (MHz) | IS11 | Zφ | S ₂₁ | ζ φ | IS ₁₂ I | Δ φ | IS ₂₂ I | 4 |
| 5.0 | 5.0 | 200 | 0.634 | -31 | 6.37 | 120 | 0.060 | 69 | 0.711 | -23 |
| 1 | | 400 | 0.469 | -34 | 3.95 | 93 | 0.107 | 65 | 0.602 | -30 |
| | | 600 | 0.379 | -40 | 2.90 | 77 | 0.147 | 62 | 0.587 | -33 |
| | | 800 | 0.368 | -51 | 2.32 | 65 | 0.183 | 56 | 0.55 | -36 |
| | | 1000 | 0.381 | -54 | 1.93 | 55 | 0.223 | 50 | 0.528 | -44 |
| 1 : | 10 | 200 | 0.523 | -29 | 7.79 | 112 | 0.056 | 72 | 0.632 | -23 |
| | | 400 | 0.418. | -28 | 3.74 | 89 | 0.104 | 68 | 0.543 | -29 |
| | - | 600 | 0.344 | -34 | 3.20 | 74 | 0.146 | 65 | 0.542 | -32 |
|] | | 800 | 0.345 | -46 | 2.54 | 64 | 0.184 | 58 | 0.513 | -34 |
| | | 1000 | 0.366 | -50 | 2.09 | 54 | 0.225 | 52 | 0.493 | -42 |
| | 20 | 200 | 0.454 | -25 | 8.43 | 106 | 0.065 | 73 | 0.584 | -21 |
| | | 400 | 0.390 | -23 | 4.67 | 85 | 0.105 | 70 | 0.513 | -27 |
| | | 600 | 0.325 | -30 | 3.31 | 72 | 0.148 | 66 | 0.620 | -30 |
| | | 800 | 0.327 | -44 | 2.61 | 62 | 0.188 | 59 | 0.497 | -32 |
| | | 1000 | 0.351 | -48 | 2.15 | 52 | 0.231 | 52 | 0.476 | -41 |
| 10 | 5.0 | 200 | 0.731 | -25 | 5.83 | 121 | 0.053 | 70 | 0.736 | -18 |
| | | 400 | 0.589 | -30 | 3.65 | 95 | 0.096 | 67 | 0.654 | -26 |
| | | 600 | 0.502 | -38 | 2.71 | 79 | 0.132 | 64 | 0.645 | -29 |
| l l | | 800 | 0.496 | -49 | 2.21 | 68 | 0.164 | 57 | 0.612 | -33 |
| ľ | | 1000 | 0.499 | -54 | 1.83 | 58 | 0.198 | 51 | 0.592 | -42 |
| | 10 | 200 | 0.643 | -25 | 7.37 | 114 | 0.051 | 71 | 0.668 | -18 |
| | | 400 | 0.542 | -27 | 4.28 | 90 | 0.094 | 69 | 0.060 | -25 |
| i i | | 600 | 0.466 | -34 | 3.10 | 76 | 0.132 | 65 | 0.603 | -28 |
| 1 1 | | 800 | 0.465 | -46 | 2.49 | 66 | 0.166 | 59 | 0.577 | -31 |
| 1 1 | | 1000 | 0.476 | -51 | 2.05 | 57 | 0.202 | 53 | 0.557 | -40 |
| | 20 | 200 | 0.57 | -23 | 8.44 | 109 | 0.049 | 73 | 0.621 | -18 |
| 1 1 | | 400 | 0.496 | -24 | 4.73 | 88 | 0.093 | 71 | 0.562 | -24 |
| 1 | | 600 | 0.427 | -31 | 3.38 | 75 | 0.131 | 67 | 0.572 | -27 |
| | | 800 | 0.427 | -43 | 2.69 | 66 | 0.165 | 60 | 0.551 | -30 |
| L | | 1000 | 0.445 | -47 | 2.21 | 57 | 0.203 | 54 | 0.532 | -38 |

MRF534 COMMON-EMITTER S-PARAMETERS

| VCE | lc | f | S ₁ | 1 | s | 21 | S- | S ₁₂ | | 22 |
|---------|------|-------|-----------------|-----|-----------------|-----|-----------------|-----------------|-------|------------|
| (Volts) | (mA) | (MHz) | S ₁₁ | 4 | S ₂₁ | 4 | S ₁₂ | Δ φ | S22 | Δ φ |
| 5.0 | 5.0 | 200 | 0.734 | -22 | 3.70 | 126 | 0.066 | 66 | 0.507 | -39 |
| | | 400 | 0.580 | -28 | 2.56 | 108 | 0.116 | 65 | 0.409 | -48 |
| | | 600 | 0.444 | -37 | 2.09 | 95 | 0.158 | 62 | 0.403 | -52 |
| | | 800 | 0.400 | -47 | 1.80 | 86 | 0.195 | 56 | 0.364 | -56 |
| | | 1000 | 0.366 | -47 | 1.55 | 79 | 0.234 | 51 | 0.348 | -69 |
| | 10 | 200 | 0.645 | -27 | 5.36 | 124 | 0.058 | 69 | 0.394 | -43 |
| | | 400 | 0.503 | -33 | 3.44 | 106 | 0.109 | 71 | 0.316 | -52 |
| | | 600 | 0.376 | -43 | 2.68 | 93 | 0.153 | 69 | 0.323 | -52 |
| | | 800 | 0.333 | -54 | 2.24 | 84 | 0.192 | 65 | 0.290 | -55 |
| | | 1000 | 0.295 | -54 | 1.91 | 77 | 0.233 | 61 | 0.276 | -71 |
| | 20 | 200 | 0.586 | -28 | 5.90 | 122 | 0.053 | 70 | 0.338 | -52 |
| | 1 | 400 | 0.454 | -34 | 3.73 | 105 | 0.099 | 73 | 0.259 | -60 |
| | | 600 | 0.329 | -46 | 2.87 | 93 | 0.143 | 72 | 0.267 | -58 |
| | | 800 | 0.289 | -59 | 2.38 | 85 | 0.181 | 68 | 0.240 | -59 |
| | | 1000 | 0.248 | -58 | 2.04 | 77 | 0.221 | 65 | 0.235 | -75 |
| 10 | 5.0 | 200 | 0.752 | -21 | 4.28 | 125 | 0.066 | 70 | 0.550 | -28 |
| | j | 400 | 0.624 | -26 | 2.77 | 107 | 0.123 | 68 | 0.495 | -38 |
| | | 600 | 0.512 | -34 | 2.19 | 94 | 0.168 | 65 | 0.503 | -44 |
| | | 800 | 0.476 | -44 | 1.86 | 86 | 0.207 | 60 | 0.464 | -51 |
| | | 1000 | 0.447 | -45 | 1.60 | 79 | 0.246 | 55 | 0.443 | -64 |
| | 10 | 200 | 0.685 | -24 | 5.47 | 123 | 0.060 | 71 | 0.442 | -33 |
| - 1 | 1 | 400 | 0.553 | -28 | 3.46 | 105 | 0.113 | 71 | 0.385 | -42 |
| ŀ | | 600 | 0.433 | -37 | 2.68 | 93 | 0.156 | 68 | 0.397 | -46 |
| | i | 800 | 0.391 | -49 | 2.25 | 85 | 0.194 | 63 | 0.362 | -51 |
| | | 1000 | 0.359 | -47 | 1.92 | 78 | 0.233 | 59 | 0.342 | -65 |
| | 20 | 200 | 0.621 | -26 | 6.38 | 121 | 0.055 | 71 | 0.372 | -40 |
| | 1 | 400 | 0.488 | -31 | 3.97 | 104 | 0.103 | 72 | 0.316 | -48 |
| 1 | ł | 600 | 0.365 | -41 | 3.04 | 93 | 0.145 | 70 | 0.332 | -50 |
| ĺ | - 1 | 800 | 0.323 | -52 | 2.51 | 85 | 0.182 | 66 | 0.301 | -54 |
| | l | 1000 | 0.290 | -50 | 2.13 | 79 | 0.219 | 63 | 0.288 | -68 |

MM4049 • MRF534 • MRF536

MRF536 COMMON-EMITTER S-PARAMETERS

| V | ıc | | S ₁ | 1 | S ₂ | 1 | S ₁ ; | 2 | S ₂ | 2 |
|------------|------|-------|-----------------|------|-----------------|------------|------------------|------------|----------------|------------|
| VCE Volts) | (mA) | (MHz) | S ₁₁ | ζφ | S ₂₁ | ζ φ | IS12 | Δ φ | S22 | Lφ |
| 5.0 | 5.0 | 400 | 0.401 | -74 | 5.38 | 108 | 0.09 | 54 | 0.49 | -48 |
| 0.0 | | 800 | 0.181 | -102 | 3.03 | 86 | 0.138 | 51 | 0.35 | -64 |
| | | 1200 | 0.136 | -157 | 2.13 | 70 | 0.181 | 48 | 0.32 | -70 |
| | | 1600 | 0.151 | 175 | 1.68 | 59 | 0.21 | 45 | 0.27 | -80 |
| | | 2000 | 0.16 | 148 | 1.44 | 52 | 0.24 | 41 | 0.269 | -100 |
| | 10 | 400 | 0.289 | -94 | 6.58 | 103 | 0.076 | 56 | 0.379 | -56 |
| | ••• | 800 | 0.14 | -137 | 3.55 | 84 | 0.122 | 55 | 0.266 | -73 |
| 1 | | 1200 | 0.174 | 169 | 2.46 | 70 | 0.165 | 53 | 0.238 | -77 |
| - 1 | | 1600 | 0.196 | 154 | 1.93 | 60 | 0.196 | 50 | 0.198 | -87 |
| ļ | , | 2000 | 0.227 | 130 | 1.65 | 51 | 0.230 | 46 | 0.202 | -110 |
| | 20 | 400 | 0.233 | -118 | 7.28 | 99 | 0.066 | 60 | 0.296 | -65 |
| | | 800 | 0.163 | -169 | 3.88 | 82 | 0.110 | 59 | 0.204 | -84 |
| | | 1200 | 0.233 | 156 | 2.65 | 69 | 0.153 | 57 | 0.179 | -84 |
| | | 1600 | 0.253 | 144 | 2.06 | 59 | 0.186 | 55 | 0.143 | -96 |
| | | 2000 | 0.290 | 123 | 1.75 | 50 | 0.220 | 51 | 0.160 | -121 |
| 10 | 5.0 | 400 | 0.478 | -54 | 5.14 | 109 | 0.086 | 58 | 0.535 | -39 |
| | 0.0 | 800 | 0.279 | -66 | 2.90 | 88 | 0.141 | 53 | 0.420 | -55 |
| | | 1200 | 0.166 | -97 | 2.08 | 73 | 0.184 | 48 | 0.388 | -62 |
| | | 1600 | 0.151 | -123 | 1.67 | 64 | 0.209 | 44 | 0.33 | -72 |
| | | 2000 | 0.110 | -158 | 1.44 | 55 | 0.243 | 39 | 0.313 | -90 |
| | 10 | 400 | 0.356 | -67 | 6.59 | 105 | 0.075 | 59 | 0.418 | -47 |
| | | 800 | 0.182 | -84 | 3.59 | 86 | 0.124 | 56 | 0.311 | -62 |
| | .4 | 1200 | 0.119 | -141 | 2.53 | 73 | 0.166 | 52 | 0.284 | -67 |
| | 1 | 1600 | 0.131 | -166 | 2.00 | 62 | 0.193 | 49 | 0.230 | -76 |
| | | 2000 | 0.135 | 154 | 1.72 | 55 | 0.226 | 45 | 0.222 | -98 |
| | 20 | 400 | 0.26 | -85 | 7.66 | 101 | 0.066 | 61 | 0.328 | -53 |
| | | 800 | 0.124 | 122 | 4.09 | 84 | 0.111 | 59 | 0.236 | -69 |
| | l | 1200 | 0.148 | 172 | 2.83 | 72 | 0.152 | 56 | 0.216 | -71 |
| | l | 1600 | 0.172 | 158 | 2.22 | 62 | 0.182 | 54 | 0.172 | -80 |
| | l | 2000 | 0.201 | 130 | 1.88 | 54 | 0.214 | 50 | 0.171 | -104 |

MM8000 MM8001 MM8002

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------------------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 30 | Vdc |
| Collector-Base Voltage | VCBO | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 3.5 | Vdc |
| Collector Current | lc | 0.4 | Adc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 3.5 20 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C |

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|----------------------------|-----------------------|--------------------|-------------|-------------|---------|
| OFF CHARACTERISTICS | _ | | | | | <u></u> |
| Collector-Emitter Sustaining Voltage (IC = 5.0 mAdc, IB = 0) | | V _{CEO(sus)} | 30 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.1 mAdc, IE = 0) | | V(BR)CBO | 40 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 0.1 mAdc, IC = 0) | <u>-</u> | V(BR)EBO | 3.5 | _ | | Vdc |
| Collector Cutoff Current (VCE = 28 Vdc, I _B = 0) | | ICEO | - | | 20 | μAdc |
| ON CHARACTERISTICS | | | _ | | | |
| DC Current Gain (IC = 50 mAdc, VCE = 15 Vdc) | - | ptE | 30 | _ | _ | _ |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product (IC = 25 mAdc, VCE = 15 Vdc, f = 200 MHz) | MM8000 MM8001 MM8002 | fτ | 550 700 1000 | _ _ _ | _ _ _ | MHz |
| (I _C = 50 mAdc, V_{CE} = 15 Vdc, f = 200 MHz) | MM8000 MM8001 MM8002 | | 700 900 1200 | = | = | |
| (I _C = 100 mAdc, V _{CE} = 15 Vdc, f = 200 MHz) | MM8000 MM8001 MM8002 | | 700 900 1000 | | <u>-</u> | |
| Output Capacitance (VCB = 30 Vdc, I _E = 0, f = 1.0 MHz) | | C _{obo} | - | _ | 3.5 | pF |
| Noise Figure (Figure 1) (I _C = 10 mAdc, V _{CE} = 15 Vdc, f = 200 MHz) | | NF | _ | 2.7 | _ | dB |
| FUNCTIONAL TEST | | | | | | |
| Common-Emitter Amplifier Power Gain (Figure 1) (I _C = 10 mAdc, V _{CE} = 15 Vdc, f = 200 MHz) | | Gpe | _ | 11.4 | _ | dB |

FIGURE 1 – 200 MHz TEST CIRCUIT

P_{in} (Rg = 50Ω)

C₁ (2_L = 50Ω)

C₂ (2₁ 1.0 – 30 pF

C₃: 1.0 – 20 pF

C₅: 10,000 pF

C₆: 10,000 pF

C₆: 10,000 pF

C₈: 0.01 μF

L₁: 4-1/2 turns, No. 22

AWG wirs, 3/18" 1.0.

L₂: 3.1/2 turns, No. 22

AWG wirs, 3/18" 1.0.

L₃: 3.1/2 turns, No. 22

AWG wirs, 3/18" 1.0.

L₄: 3.1/2 turns, No. 22

AWG wirs, 3/18" 1.0.

L₅: 1.3: 0.82 μH RFC

R₁: 240 ohms, 2 weits

MM8009

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| MAXIMOM RATINGS | | | | | | | |
|---|-----------------------------------|-------------|----------------|--|--|--|--|
| Rating | Symbol | Value | Unit | | | | |
| Collector-Emitter Voltage | VCEO | 35 | Vdc | | | | |
| Collector-Base Voltage | V _{CBO} | 45 | Vdc | | | | |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc | | | | |
| Collector Current — Continuous | lc | 400 | mAdc | | | | |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.71 | Watt mW/°C | | | | |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 3.5 20 | Watts mW/°C | | | | |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | -65 to +200 | °C | | | | |

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|------------------|------|-----|-----|-------------|
| OFF CHARACTERISTICS | | | • | | |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 45 | _ | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 100 µAdc, I _C = 0) | V(BR)EBO | 3.0 | _ | | Vdc |
| Collector Cutoff Current (VCE = 15 Vdc, lg = 0) | ICEO | - | _ | 100 | μAdc |
| Collector Cutoff Current (VCE = 35 Vdc, VBE = 0) | ICES | - | - | 10 | μAdc |
| ON CHARACTERISTICS | | | | 1 | |
| DC Current Gain (IC = 100 mAdc, VCE = 5.0 Vdc) | hFE | 20 | _ | - | - |
| SMALL SIGNAL CHARACTERISTICS | | | | · | <u> </u> |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 15 Vdc, f = 100 MHz) | fT | 1000 | _ | - | MHz |
| Output Capacitance (VCB = 30 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | | 2.3 | 3.0 | pF |
| FUNCTIONAL TEST | | | | | • |
| Power Output (Figure 1) (Pin = 316 mW, VCE = 28 Vdc, f = 1.0 GHz) | P _{out} | 0.9 | _ | _ | Watt |
| Power Output (Oscillator) (Figure 2) (VCE = 20 Vdc, VEB = 1.5 Vdc, f = 1.68 GHz) (Minimum Efficiency = 15%) | Pout | _ | 0.3 | - | Watt |
| Collector Efficiency (Pin = 316 mW, V _{CE} = 28 Vdc, f = 1.0 GHz) | η | 35 | _ | _ | % |

MM8009

FIGURE 1 - 1.0 GHz POWER AMPLIFIER TEST CIRCUIT

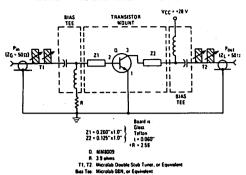


FIGURE 2 - 1.68 GHz POWER OSCILLATOR TEST CIRCUIT

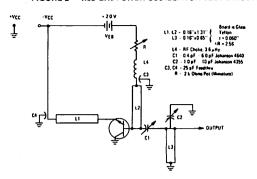
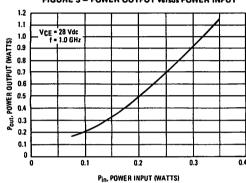


FIGURE 3 - POWER OUTPUT versus POWER INPUT



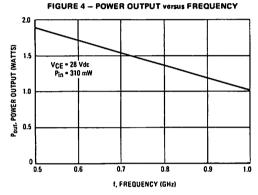


FIGURE 5 - POWER OUTPUT versus VOLTAGE

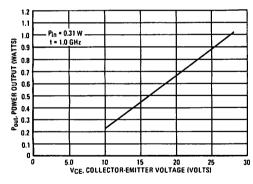
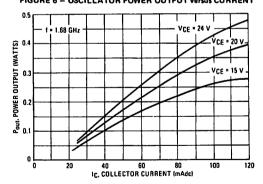
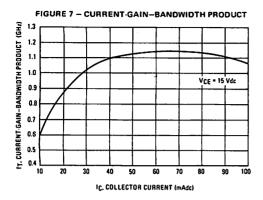
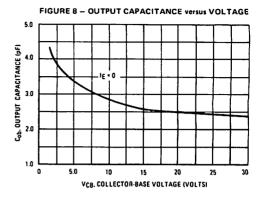


FIGURE 6 - OSCILLATOR POWER OUTPUT versus CURRENT







CASE 79-02, STYLE 1 TO-39 (TO-205AD)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

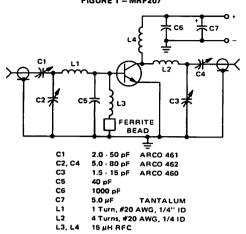
| Rating | Symbol | Value | Unit |
|---|------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 18 | Vdc |
| Collector-Base Voltage | V _{CBO} | 36 | Vdc |
| Emitter-Base Voltage | V _{EBO} | 4.0 | Vdc |
| Collector Current — Continuous | lc lc | 0.4 | Adc |
| Total Device Dissipation @ T _C = 25°C(1) Derate above 25°C | PD | 3.5 20 | Watts mW/°C |
| Storage Temperature | T _{stg} | -65 to +200 | •€ |

⁽¹⁾ This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

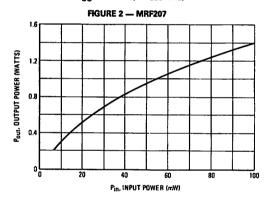
| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|----------|-----|--------------|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 5.0 mAdc, Ig = 0) | V(BR)CEO | 18 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 2.0 mAdc, IE = 0) | V(BR)CBO | 36 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 1.0 mAdc, IC = 0) | V(BR)EBO | 4.0 | - | | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) | ICBO | | _ | 0.1 | mAdc |
| ON CHARACTERISTICS | | | | | , |
| DC Current Gain (IC = 100 mAdc, VCE = 5.0 Vdc) | hFE | 5.0 | _ | _ | |
| FUNCTIONAL TEST | | | | | |

| Common-Emitter Amplifier Power Gain (VCC = 12.5 Vdc, Pout = 1.0 W, f = 220 MHz) | GPE | 8.2 | 12.5 | _ | dB |
|---|------------------|-----|------------|---|------|
| Input Impedance (Pout = 1.0 W, f = 220 MHz) | z _{in} | _ | 10 – j11.5 | _ | Ohms |
| Output Impedance (Pout = 1.0 W, f = 220 MHz) | Z _{out} | _ | 32 – j41 | - | Ohms |

220 MHz TEST CIRCUIT FIGURE 1 – MRF207



OUTPUT POWER versus INPUT POWER (V_{CC} = 12.5 Vdc, f = 220 MHz)



CASE 79-02, STYLE 1 TO-39 (TO-205AD)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 18 | Vdc |
| Collector-Base Voltage | V _{CBO} | 36 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | lc | 0.25 | Adc |
| Total Device Dissipation @ T _C = 25°C(1) Derate above 25°C | PD | 3.5 0.02 | Watts mW/°C |
| Storage Temperature | T _{stg} | -65 to +200 | ౡ |

⁽¹⁾ These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as Class C RF amplifiers.

| Characteristic | Symbol | Min | Max | Unit |
|--|------------------|-----|-----|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 20 mAdc, Ig = 0) | V(BR)CEO | 18 | | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 20 mAdc, VBE = 0) | V(BR)CES | 36 | - | Vdc |
| Emitter-Base Breakdown Voltage | V(BR)EBO | 4.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) | ІСВО | _ | 100 | μAdc |
| ON CHARACTERISTICS | | | | , |
| DC Current Gain (IC = 100 mAdc, VCE = 5.0 Vdc) | hFE | 15 | 150 | |
| SMALL SIGNAL CHARACTERISTICS | | | | |
| Output Capacitance (V _{CB} = 12 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | | 8.0 | pF |
| FUNCTIONAL TEST (FIGURE 1) | | | | ···· |
| Common-Emitter Amplifier Power Gain (Pout = 1.5 W, V _{CC} = 12.5 Vdc, f = 225 MHz) | GPE | 9.0 | | dB |
| Collector Efficiency (Pout = 1.5 W, VCC = 12.5 Vdc, f = 225 MHz) | η | 50 | | % |

FIGURE 1 - 225 MHz TEST CIRCUIT SCHEMATIC

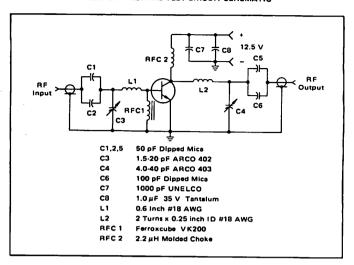


FIGURE 2 - OUTPUT POWER versus INPUT POWER

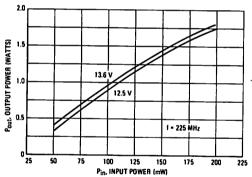
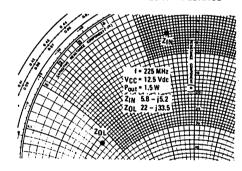


FIGURE 3 - SERIES EQUIVALENT IMPEDANCE



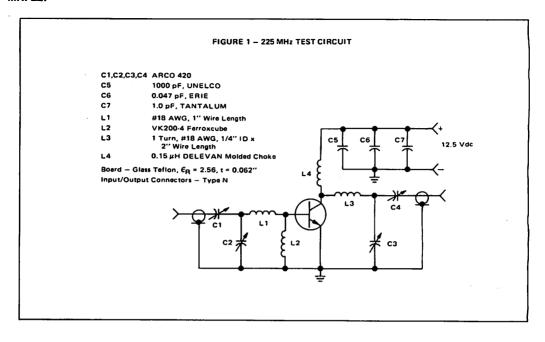
CASE 79-03, STYLE 5
HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 16 | Vdc |
| Collector-Base Voltage | VCBO | 36 | Vdc |
| Emitter-Base Voltage | VEBO | 400 | mdc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.5 | Watts mW/°C |
| Storage Temperature | T _{stq} | -65 to +200 | °C |

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|------------------|------|-----|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 50 mAdc, I _B = 0) | V(BR)CEO | 16 | _ | _ | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 50 mAdc, VBE = 0) | V(BR)CES | 36 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 1.0 mAdc, I _C = 0) | V(BR)EBO | 4.0 | _ | - | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) | ІСВО | _ | _ | 1.0 | mAdc |
| Collector Cutoff Current (VCE = 15 Vdc, VBE = 0, TC = 55°C) | ICES | _ | | 10 | mAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 100 mAdc, V _{CE} = 5.0 Vdc) | hFE | 20 | _ | 200 | |
| SMALL SIGNAL CHARACTERISTICS | | | | | |
| Output Capacitance (VCB = 12.5 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | _ | _ | 15 | pF |
| FUNCTIONAL TEST (FIGURE 1) | | | | | |
| Common-Emitter Amplifier Power Gain (Pout = 3.0 W, VCC = 12.5 Vdc, f = 225 MHz) | GPE | 13.5 | 15 | _ | dB |
| Collector Efficiency (Pout = 3.0 W, V _{CC} = 12.5 Vdc, f = 225 MHz) | η | 60 | _ | _ | % |



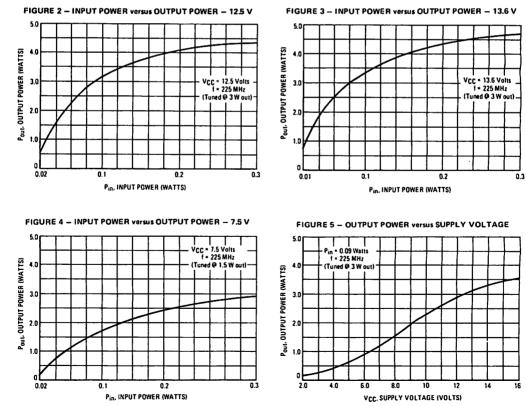
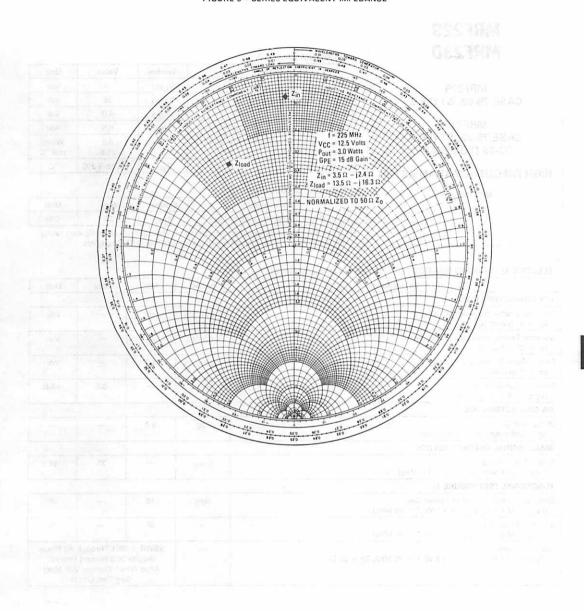


FIGURE 6 - SERIES EQUIVALENT IMPEDANCE



MRF229 MRF230

MRF229 CASE 79-03, STYLE 5

MRF230 CASE 79-02, STYLE 1 TO-39 (TO-205AD)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

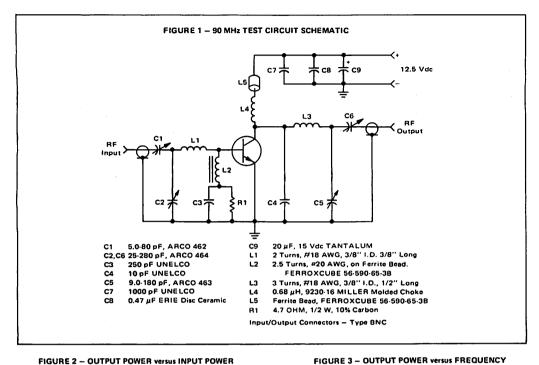
| Rating | Symbol | Value | Unit |
|---|--------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 18 | Vdc |
| Collector-Base Voltage | VCBO | 36 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | lc | 0.5 | Adc |
| Total Device Dissipation @ T _C = 25°C(1) Derate above 25°C | PD | 5.0 28.6 | Watts mW/°C |
| Storage Temperature | Tstg | -65 to +200 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|--------------------------------------|--------|-----|------|
| Thermal Resistance, Junction to Case | ReJC | 35 | °C/W |

⁽¹⁾ These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as Class C RF Amplifiers.

| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|--|-----|----------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (IC = 25 mAdc, Ig = 0) | V(BR)CEO | 18 | _ | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 25 mAdc, VBE = 0) | V(BR)CES | 36 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 0.25 mAdc, I _C = 0) | V(BR)EBO | 4.0 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 15 Vdc, I _E = 0) | ІСВО | | 0.5 | mAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 250 mAdc, V _{CE} = 5.0 Vdc) | hFE | 5.0 | _ | <u> </u> |
| SMALL SIGNAL CHARACTERISTICS | | | | |
| Output Capacitance (V _{CB} = 12.5 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | 1 | 25 | pF |
| FUNCTIONAL TEST (FIGURE 1) | | | | |
| Common-Emitter Amplifier Power Gain (VCC = 12.5 Vdc, Pout = 1.5 W, f = 90 MHz) | GPE | 10 | | dB |
| Collector Efficiency (VCC = 12.5 Vdc, P _{Out} = 1.5 W, f = 90 MHz) | η | 55 | - | % |
| Load Mismatch (VCC = 12.5 Vdc, P_{Out} = 1.5 W, f = 90 MHz, $T_C \le 25^{\circ}$ C) | _ | VSWR > 30:1 Through All Phase Angles in 3 Second Interval After Which Devices Will Meet GPE Test Limits | | |



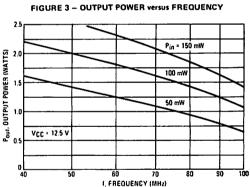
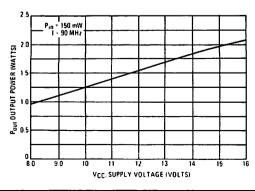
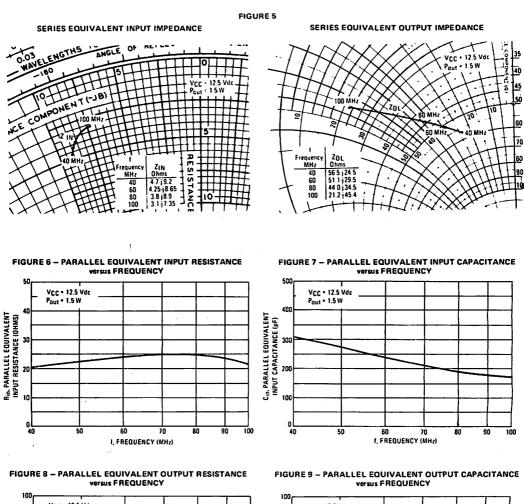
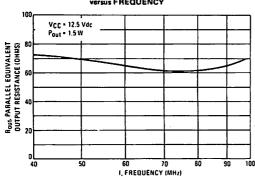
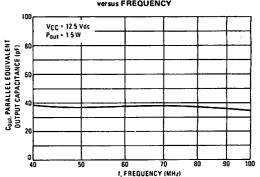


FIGURE 4 - OUTPUT POWER versus SUPPLY VOLTAGE









MAXIMUM RATINGS

| MAXIMUM KATINGS | | | |
|--|------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 18 | Vdc |
| Collector-Base Voltage | VCBO | 36 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | lc | 640 | mAdc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 8.0 45.7 | Watts mW/°C |
| Storage Temperature | T _{stg} | -65 to +200 | °C |

THERMAL CHARACTERISTICS

| ١ | Characteristic | Symbol | Max | Unit |
|---|--------------------------------------|--------|-----|------|
| l | Thermal Resistance, Junction to Case | ReJC | 20 | °C/W |

MRF237

CASE 79-03, STYLE 5
HIGH FREQUENCY TRANSISTOR
NPN SILICON

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|------------------|----------|-----|------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 10 mAdc, Ig = 0) | V(BR)CEO | 18 | _ | _ | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 5.0 mAdc, VBE = 0) | V(BR)CES | 36 | | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 1.0 mAdc, I _C = 0) | V(BR)EBO | 4.0 | _ | - | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, I _E = 0) | Ісво | - | _ | 0.25 | mAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 250 mAdc, V _{CE} = 5.0 Vdc) | pŁE | 5.0 | _ | _ | _ |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Output Capacitance (VCB = 15 Vdc, I _E = 0, f = 0.1 MHz) | C _{obo} | | 15 | 20 | pF |
| FUNCTIONAL TEST (FIGURE 1) | | | | | |
| Common-Emitter Amplifier Power Gain (Pout = 4.0 W, VCC = 12.5 Vdc, IC(max) = 640 mAdc, f = 175 MHz) | GpE | 12 | 14 | _ | dB |
| Collector Efficiency (Pout = 4.0 W, VCC = 12.5 Vdc, IC(max) = 640 mAdc, f = 175 MHz) | η | 50 | 62 | _ | % |

FIGURE 1 - 175 MHz TEST CIRCUIT SCHEMATIC

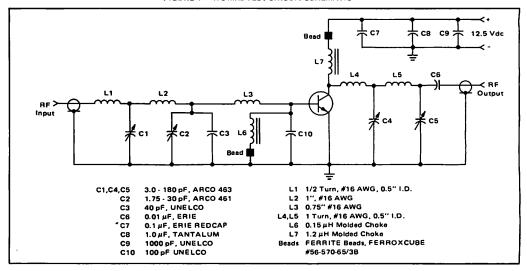


FIGURE 2 — OUTPUT POWER versus INPUT POWER

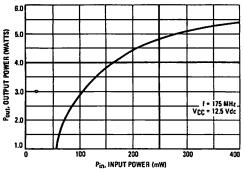


FIGURE 3 - OUTPUT POWER versus FREQUENCY

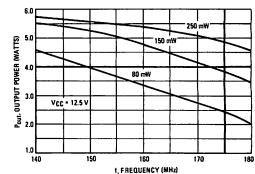


FIGURE 4 - OUTPUT POWER versus SUPPLY VOLTAGE

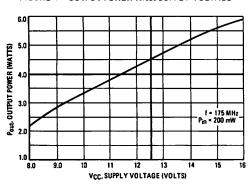
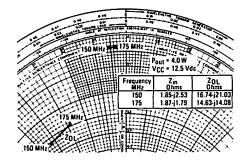


FIGURE 5 - SERIES EQUIVALENT IMPEDANCE



MRF313 MRF313A

MRF313 CASE 305A-01, STYLE 1

MRF313A **CASE 305-1, STYLE 1**

HIGH FREQUENCY TRANSISTOR

NPN SILICON

Max

Unit

Min

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 30 | Vdc |
| Collector-Base Voltage | V _{CBO} | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | lc | 150 | mAdc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.5 35 | Watts mW/°C |
| Storage Temperature | T _{stg} | -65 to +200 | °C |

THERMAL CHARACTERISTICS

| 1 | Characteristic | Symbol | Max | Unit |
|---|--------------------------------------|-------------------|------|------|
| | Thermal Resistance, Junction to Case | R ₆ JC | 28.5 | °C/W |

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

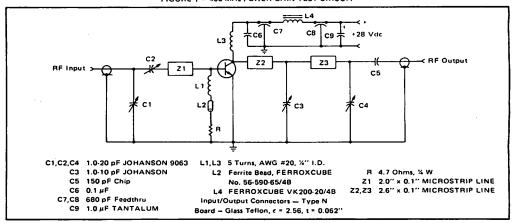
Symbol Characteristic Тур **OFF CHARACTERISTICS** Collector-Emitter Breakdown Voltage V(BR)CEO 30 Vdc $(I_C = 10 \text{ mAdc}, I_B = 0)$ Collector-Emitter Breakdown Voltage V(BR)CES 35 Vdc (IC = 5.0 mAdc, $V_{BE} = 0$) Collector-Base Breakdown Voltage 35 Vdc V(BR)CBO (IC = 0.1 mAdc, IE = 0) Emitter-Base Breakdown Voltage (IE = 1.0 mAdc, IC = 0) V(BR)EBO 3.0 Vdc Collector Cutoff Current **ICEO** 1.0 mAdc (VCE = 20 Vdc, lg = 0) ON CHARACTERISTICS DC Current Gain hFE 20 60 150 (IC = 100 mAdc, VCE = 10 Vdc) **SMALL SIGNAL CHARACTERISTICS**

| Current-Gain — Bandwidth Product (IC = 100 mAdc, VCE = 20 Vdc, f = 200 MHz) | ft | _ | 2.5 | _ | GHz |
|---|------|---|-----|-----|-----|
| Output Capacitance (VCB = 28 Vdc, IE = 0, f = 1.0 MHz) | Cobo | _ | 3.5 | 5.0 | pF |
| FUNCTIONAL TEST | | | | | |

| Common-Emitter Amplifier Power Gain(1) (V _{CC} = 28 Vdc, P _{Out} = 1.0 W, f = 400 MHz) | Gpe | 15 | 16 | _ | dB |
|---|------------------|----|------------|---|------|
| Collector Efficiency (V _{CC} = 28 Vdc, P _{Out} = 1.0 W, f = 400 MHz) | η | _ | 45 | _ | % |
| Series Equivalent Input Impedance (VCC = 28 Vdc, Pout = 1.0 W, f = 400 MHz) | Z _{in} | _ | 6.4 – j4.8 | - | Ohms |
| Series Equivalent Output Impedance {VCC = 28 Vdc, Pout = 1.0 W, f = 400 MHz} | Z _{out} | _ | 75 – j45 | | Ohms |

(1) Class C

FIGURE 1 - 400 MHz POWER GAIN TEST CIRCUIT



CASE 79-02, STYLE 1 TO-39 (TO-205AD)

HIGH FREQUENCY TRANSISTOR

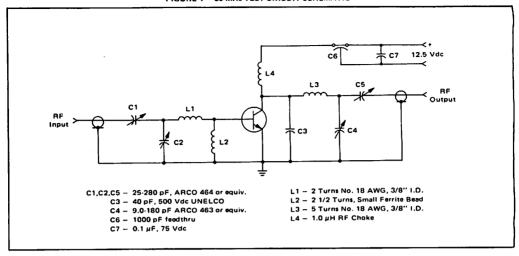
NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 18 | Vdc |
| Collector-Base Voltage | VCBO | 36 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | lc | 0.5 | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.62 | Watts mW/°C |
| Storage Temperature | T _{sta} | -65 to +200 | °C |

| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|-----|-----|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 100 mAdc, I _B = 0) | V(BR)CEO | 18 | | Vdc |
| Collector-Emitter Breakdown Voltage (I _C = 100 mAdc, V _{BE} = 0) | V(BR)CES | 36 | - | Vdc |
| Emitter-Base Breakdown Voltage (Ig = 0.25 mAdc, IC = 0) | V(BR)EBO | 4.0 | _ | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, Ig = 0) | ICBO | _ | 0.5 | mAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (IC = 250 mAdc, VCE = 5.0 Vdc) | pŁE | 5.0 | _ | _ |
| SMALL-SIGNAL CHARACTERISTICS | | | • | |
| Output Capacitance (V _{CB} = 15 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | _ | 25 | pF |
| FUNCTIONAL TEST (FIGURE 1) | | | | |
| Common-Emitter Amplifier Power Gain (VCC = 12.5 Vdc, Pout = 1.0 W, IC(max) = 160 mAdc, f = 50 MHz) | GPE | 10 | _ | dB |
| Collector Efficiency (VCC = 12.5 Vdc, P _{out} = 1.0 W, I _C (max) = 160 mAdc, f = 50 MHz) | η | 50 | | % |

FIGURE 1 - 50 MHz TEST CIRCUIT SCHEMATIC



MRF501 MRF502

CASE 20-03. STYLE 10 TO-72 (TO-206AF)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

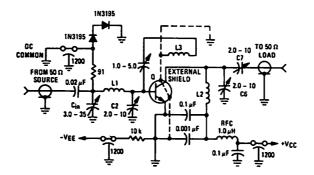
Refer to 2N5179 for curves

MAXIMUM RATINGS

| Rating | Symbol | MRF501 | MRF502 | Unit |
|---|--------|-------------|--------|-------------|
| Collector-Emitter Voltage | VCEO | 1! | 5 | Vdc |
| Collector-Base Voltage | VCBO | 25 | 35 | Vdc |
| Emitter-Base Voltage | VEBO | 3.5 | | Vdc |
| Collector Current | lc | 50 | | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 200 1.14 | | mW mW/°C |
| Storage Temperature | Tsto | - 65 to | +200 | °C |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.) Characteristic **Symbol** Min Тур Max Unit OFF CHARACTERISTICS Vdc V(BR)CEO 15 Collector-Emitter Breakdown Voltage $(I_C = 3.0 \text{ mAdc}, I_B = 0)$ Vdc V(BR)CBO Collector-Base Breakdown Voltage MRF501 25 $(I_C = 1.0 \, \mu Adc, I_E = 0)$ MRF502 35 Vdc V(BR)EBO 3.5 Emitter-Base Breakdown Voltage $(l_E = 1.0 \, \mu Adc, l_C = 0)$ nAdc **Collector Cutoff Current ICBO** MRF501 50 (VCB = 1.0 Vdc, IE = 0) MRF502 20 ON CHARACTERISTICS DC Current Gain hFE MRF501 30 250 (IC = 1.0 mAdc, VCE = 6.0 Vdc) MRF502 40 170 SMALL SIGNAL CHARACTERISTICS Current-Gain - Bandwidth Product ſΤ MHz MRF501 600 1000 $(1_{C} = 5.0 \text{ mAdc}, V_{CE} = 6.0 \text{ Vdc}, f = 100 \text{ MHz})$ MRF502 800 2000 0.6 ρF C_{cb} Collector-Base Capacitance $(V_{CB} = 10 \text{ Vdc}, I_{E} = 0, f = 0.1 \text{ to } 1.0 \text{ MHz})$ rb'C_C 8.0 Collector Base Time Constant D8 $(I_E = 2.0 \text{ mAdc, V}_{CB} = 6.0 \text{ Vdc, f} = 31.8 \text{ MHz})$ Noise Figure (Figure 1) NF dB (IC = 1.5 mAdc, VCE = 6.0 Vdc, MRF501 4.5 Rs = 50 ohms, f = 200 MHz) MRF502 4.0 **FUNCTIONAL TEST** Gpe dB Common-Emitter Amplifier Power Gain (Figure 1) MRF501 15 (VCC = 6.0 Vdc, IC = 5.0 mAdc, f = 200 MHz) MRF502 17

FIGURE 1 – 200 MHz AMPLIFIER POWER GAIN AND NOISE FIGURE CIRCUIT



- L1 13/4 Turns, #18 AWG, 0.5" Long, 0.5" Diameter L2 2 Turns, #18 AWG, 0.5" Long, 0.5" Diameter L3 2 Turns, #18 AWG, 0.25" Long, 0.5" Diameter, Position Approximately 0.25" from L2

CASE 244A-01, STYLE 1 TO-117

HIGH FREQUENCY TRANSISTOR

NPN SILICON

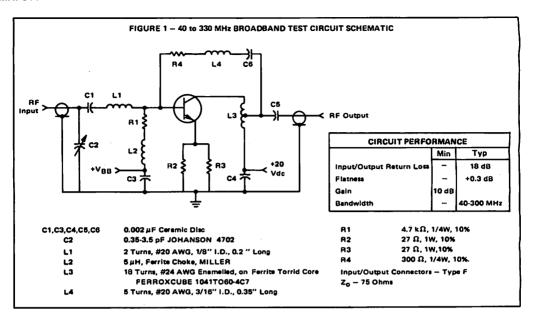
MAXIMUM RATINGS

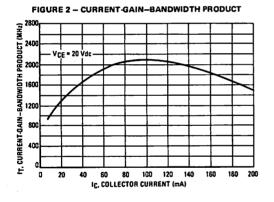
| Rating | Symbol | Value | Unit |
|---|------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Base Voltage | VCBO | 35 | Vdc |
| Emitter-Base Voltage | VEBO | 3.5 | Vdc |
| Collector Current — Continuous | lc | 250 | mAdc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 28.6 | Watts mW/°C |
| Storage Temperature | T _{stg} | -65 to +200 | °C |
| Stud Torque(1) | | 6.5 | ln. Lb. |

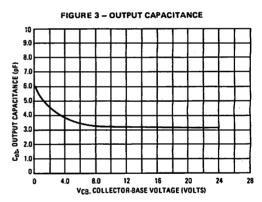
ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

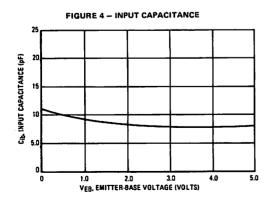
(1) For Repeated Assembly use 5 In. Lb.

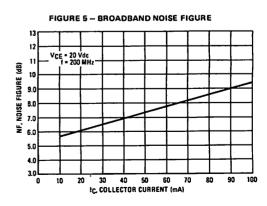
| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|-----------------|--------------------------|------------|--------------|----------|-------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 5.0 mAdc, I _B = 0) | | V(BR)CEO | 20 | _ | | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 µAdc, I _E = 0) | | V(BR)CBO | 35 | _ | 1 | . Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 µAdc, IC = 0) | | V(BR)EBO | 3.5 | _ | _ | Vdc |
| Collector Cutoff Current (VCE = 15 Vdc, IB = 0) | | ICEO | _ | 1 | 100 | μAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gein (IC = 80 mAde, VCE = 10 Vdc) | | hFE | 25 | 50 | 200 | _ |
| Collector-Emitter Saturation Voltage (IC = 100 mAdc, Ig = 10 mAdc) | | VCE(sat) | _ | 0.2 | 0.5 | Vdc |
| SMALL SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product (IC = 80 mAdc, VCE = 20 Vdc, f = 200 MHz) | | fT | 1.5 | 2.1 | - | GHz |
| Output Capacitance (VCB = 20 Vdc, IE = 0, f = 1.0 MHz) | | C _{obo} | _ | 3.2 | 4.5 | pF |
| Noise Figure (IC = 50 mAdc, VCE = 20 Vdc, f = 200 MHz) | | NF | - . | 7.3 | 10 | dB |
| FUNCTIONAL TEST (FIGURE 1) | | | | | | |
| Common-Emitter Amplifier Power Gain (VCE = 20 Vdc, IC = 80 mAdc, f = 250 MHz) | | Gpe | 10 | 11 | _ | dB |
| 2nd Order Intermodulation Distortion (VCE = 20 Vdc, IC = 80 mAdc, V _{out} = +50 dBmV, Chn 2 + Chn 13 = 266.5 MHz) | | IMD | 1 | - 55 | -50 | dB |
| Cross-Modulation Distortion (VCE = 20 Vdc, Vout = +50 dBmV, I _C = 80 mAdc) | Chn 13 Chn R | 12 Chn XMD 30 Chn XMD | | - 59 - 46 | -57 — | dΒ |
| Triple Beat (VCE = 20 Vdc, IC = 80 mAdc, V _{out} = +50 dBmV, Chn 2 + Chn 3 + Chn E = 261.75 MHz) | | ТВ | _ | -68 | - 65 | dB |

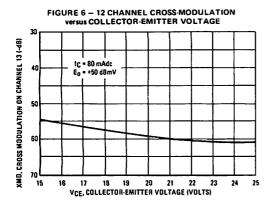


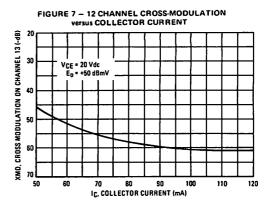


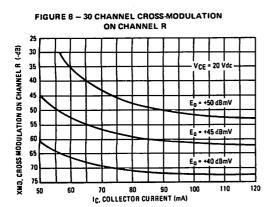


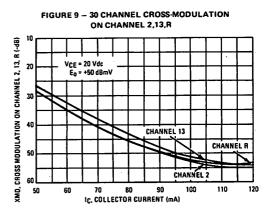


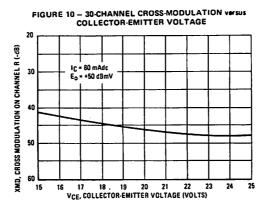












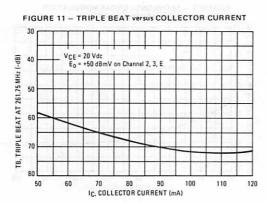


FIGURE 12 – TRIPLE BEAT versus COLLECTOR EMITTER VOLTAGE

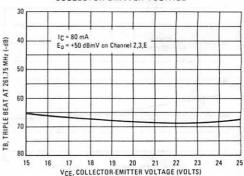


FIGURE 13 – SECOND ORDER IMD versus COLLECTOR CURRENT

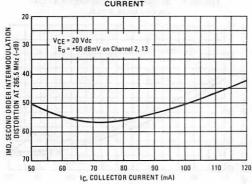


FIGURE 14 – SECOND ORDER IMD versus COLLECTOR-EMITTER VOLTAGE

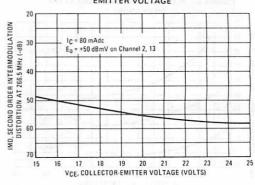
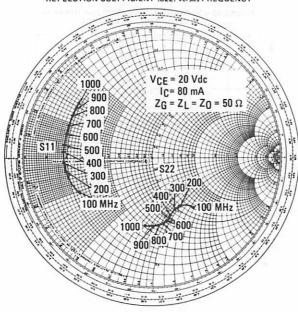
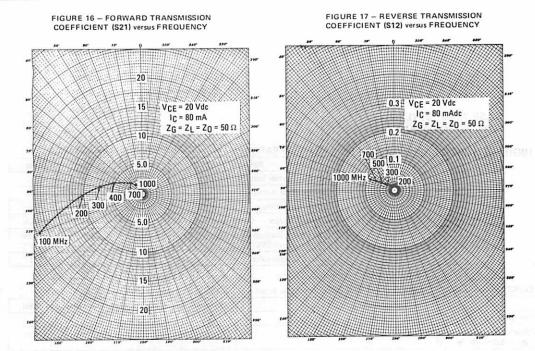


FIGURE 15 – INPUT REFLECTION COEFFICIENT (S11) AND OUTPUT REFLECTION COEFFICIENT (S22) versus FREQUENCY





CASE 79-02, STYLE 1 TO-39 (TO-205AD)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

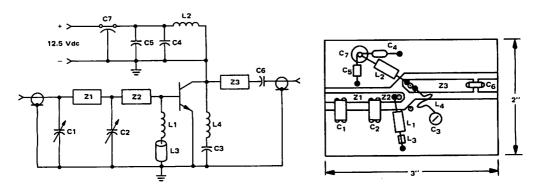
MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|--------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Colector-Base Voltage | VCBO | 35 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | ΙC | 150 | mAdc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.5 14.3 | Watts mW/°C |
| Storage Temperature | Tstg | -65 to +200 | °C |

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|------------------|------|----------|-----|------|
| OFF CHARACTERISTICS | | | | | • |
| Collector-Emitter Breakdown Voltage (I _C = 5.0 mAdc, I _B = 0) | V(BR)CEO | 20 | - | - | Vdc |
| Collector-Base Breakdown Voltage (I _C = 100 µAdc, I _E = 0) | V(BR)CBO | 35 | _ | - | Vdc |
| Emitter-Base Breakdown Voltage (Ig = 100 µAdc, IC = 0) | V(BR)EBO | 4.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCE = 15 Vdc, IB = 0) | ICEO | _ | - | 10 | μAdc |
| ON CHARACTERISTICS | <u> </u> | | | - | |
| DC Current Gain (I _C = 50 mAdc, V _{CE} = 10 Vdc) | pEE | 20 | 60 | 150 | - |
| Collector-Emitter Saturation Voltage (I _C = 50 mAdc, I _B = 5.0 mAdc) | VCE(sat) | - | _ | 0.5 | Vdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (I _C = 100 mAdc, V _{CE} = 10 Vdc, f = 200 MHz) | fŢ | 1800 | 2000 | _ | MHz |
| Output Capacitance (VCB = 12.5 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | _ | 3.5 | 4.0 | pF |
| FUNCTIONAL TEST (FIGURE 1) | | | | | |
| Common-Emitter Amplifier Power Gain (VCC = 12.5 Vdc, P _{out} = 0.75 W, f = 470 MHz) | GPE | 8.0 | 8.5 | _ | dB |
| Collector Efficiency (VCC = 12.5 Vdc, P _{out} = 0.75 W, f = 470 MHz) | η | 50 | 70 | _ | % |
| Series Equivalent Input Impedance (VCC = 12.5 Vdc, P _{Out} = 0.75 W, f = 470 MHz) | Z _{in} | _ | 14+j4.0 | _ | Ohms |
| Series Equivalent Output Impedance (VCC = 12.5 Vdc, Pout = 0.75 W, f = 470 MHz) | Z _{out} | _ | 28 – j38 | _ | Ohms |

FIGURE 1 - 470 MHz TEST CIRCUIT



C1,C2,C3 - 1.0-10 pF JOHANSON

BOARD = 0.032" TEFLON GLASS, €R = 2.5

C4 - 0.1 µF disc

C5 - 1.0 #F TANTULAM

C6 - 0.018 µF chip

C7 - 1000 pF Feedthru L1, L2 - 0.15 µF Choke

L3 - Bead Ferrite

21,Z2 · 0.09" × 0.5" LINE, $Z_0 = 100 \Omega$ 23 · 0.18" × 1.0" LINE, $Z_0 = 50 \Omega$

FIGURE 2 - OUTPUT POWER versus INPUT POWER

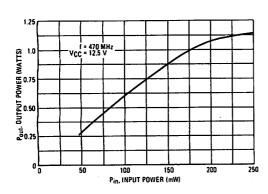


FIGURE 3 - CURRENT-GAIN - BANDWIDTH PRODUCT versus COLLECTOR CURRENT

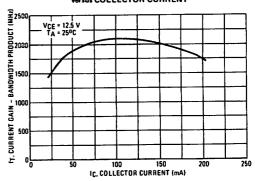


FIGURE 4 - OUTPUT CAPACITANCE versus COLLECTOR BASE VOLTAGE

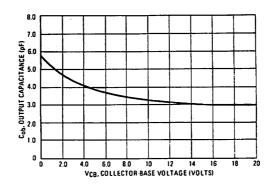
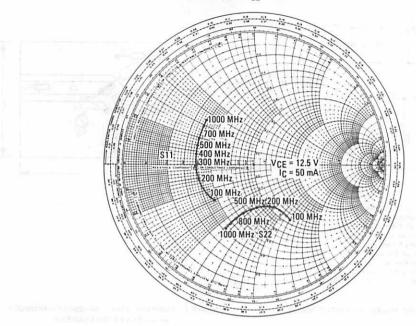
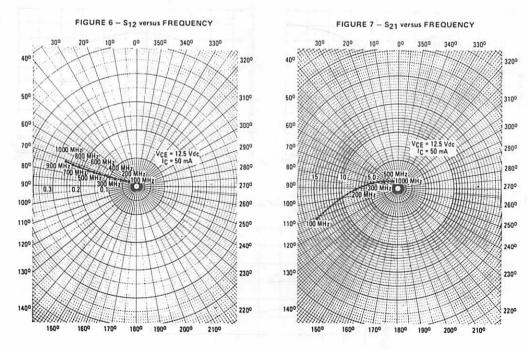


FIGURE 5 - S₁₁ and S₂₂ versus FREQUENCY





MAXIMUM RATINGS

| MAXIMUM NATINGS | | | |
|--|------------------|-------------|----------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage (R _{BE} = 330Ω) | VCER | 25 | Vdc |
| Collector-Base Voltage | V _{CBO} | 35 | Vdc |
| Emitter-Base Voltage | VEBO | 3.5 | Vdc |
| Collector Current — Continuous | lc | 150 | mAdc |
| Total Device Dissipation @ T _C = 50°C Derate above 50°C | PD | 2.5 20.0 | Watts mW/°C |
| Junction Temperature | TJ | + 175 | °C |
| Storage Temperature | Tsto | -65 to +200 | °c |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|--------------------------------------|--------|-----|------|
| Thermal Resistance, Junction to Case | RAJC | 50 | °C/W |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

MRF517

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|-------------------|------|------|------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 5.0 mAdc, I _B = 0) | V(BR)CEO | 20 | _ | _ | Vdc |
| Collector-Emitter Breakdown Voltage (I _C = 5.0 mAdc, R _{BE} = 330 Ohms) | V(BR)CER | 25 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 35 | _ | _ | Vđc |
| Emitter-Base Breakdown Voltage (IE = 100 µAdc, IC = 0) | V(BR)EBO | 3.5 | _ | _ | Vdc |
| Collector Cutoff Current (VCE = 15 Vdc, lg = 0) | ICEO | _ | | 100 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (tc = 60 mAdc, VcE = 10 Vdc) | hFE | 40 | | 200 | - |
| SMALL SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 60 mAdc, VCE = 15 Vdc, f = 200 MHz) | fr | 2200 | 2700 | | MHz |
| Output Capacitance (V _{CB} = 15 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | _ | 3.0 | 4.5 | pF |
| FUNCTIONAL TEST (FIGURE 1) | | | | | |
| Common-Emitter Amplifier Power Gain (VCE = 15 Vdc, IC = 60 mAdc, f = 300 MHz) | G _{pe} | _ | 10 | | dB |
| Broadband Noise Figure (VCE = 15 Vdc, IC = 50 mAdc, f = 300 MHz) | NF | | _ | 7.5 | dB |
| 2nd Order Distortion (V _{CE} = 15 Vdc, I _C = 60 mAdc, E _{out} = +45 dBmV, Ch 2 + Ch G = 212.5 MHz) | IMD ₂ | | | - 57 | dB |
| NCTA Cross Modulation Distortion, 12 Ch's (2-13) (V _{CE} = 15 Vdc, I _C = 60 mAdc, E _{out} = +45 dBmV, Measured at Ch's 2 and 13) | XMD ₁₂ | _ | - | - 57 | dB |
| Triple Beat Distortion, 3 Ch's (V _{CE} = 15 Vdc, I _C = 60 mAdc, E _{Out} = +45 dBmV, Ch's (4 + 5 + A) = 265 MHz) | тв ₃ | - | _ | -72 | dB |

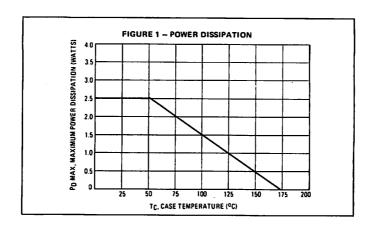
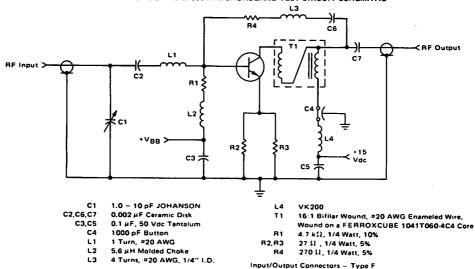


FIGURE 2 - 40 to 330 MHz BROADBAND TEST CIRCUIT SCHEMATIC



Z_o = 75 Ohms

FIGURE 3 – TYPICAL RESPONSE CURVE (See Figure 2)

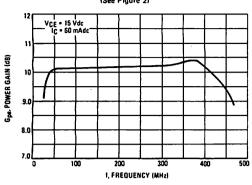


FIGURE 4 - COMMON-EMITTER POWER GAIN

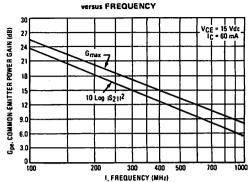


FIGURE 5 — CURRENT GAIN BANDWIDTH PRODUCT Versus COLLECTOR CURRENT

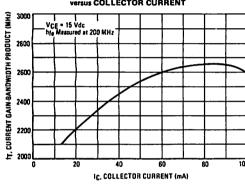


FIGURE 6 - INPUT CAPACITANCE versus

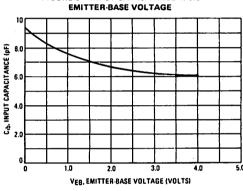


FIGURE 7 — OUTPUT CAPACITANCE versus
COLLECTOR-BASE VOLTAGE

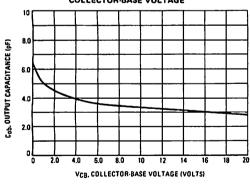


FIGURE 8 - BROADBAND NOISE FIGURE versus

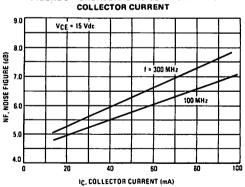


FIGURE 9 – 2nd ORDER DISTORTION (f₁ ± f₂) versus COLLECTOR CURRENT

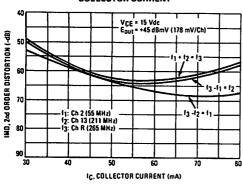


FIGURE 10 – 12-CHANNEL CROSS MODULATION DISTORTION Versus COLLECTOR CURRENT

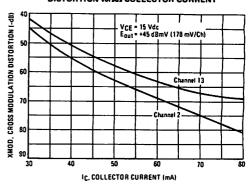


FIGURE 11 - DIN 45004 CROSS-MODULATION DISTORTION

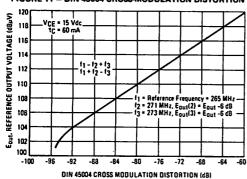


FIGURE 12 — TRIPLE BEAT DISTORTION (f₁ + f₂ + f₃) versus COLLECTOR CURRENT

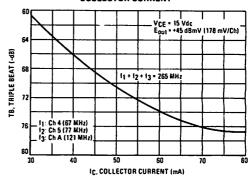
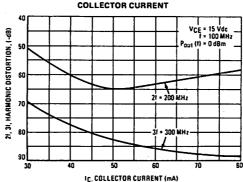


FIGURE 13 – HARMONIC DISTORTION (2f, 3f) versus



| VCE | ¹c | Frequency | S1 | 1 | S21 | | S1: | 2 | \$2 | 2 |
|---|------|------------|----------------|--------------|-----------------|-----------|----------------|----------|----------------|--------------|
| (Volts) | (mA) | (MHz) | S11 | Lφ | S211 | Lφ | S12 | Lφ | IS221 | Lφ |
| ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, | | 100 | 0.538 | -152 | 12.821 | 100 | 0.043 | 49 | 0.381 | -102 |
| | | 200 | 0.546 | -173 | 6.612 | 86 | 0.064 | 55 | 0.314 | -121 |
| | | 400 | 0.557 | 163 | 3.440 | 71 | 0.105 | 60 | 0.315 | -132 |
| 5 | 30 | 600 | 0.602 | 147 | 2.357 | 59 | 0.144 | 61 | 0.360 | -140 |
| | | 800 | 0.625 | 136 | 1.872 | 46 | 0.181 | 59 | 0.437 | -143 |
| | | 1000 | 0.626 | 120 | 1.614 | 34 | 0.211 | 57 | 0.482 | -144 |
| | | 100 | 0.532 | -160 | 13,475 | 98 | 0.040 | 54 | 0.362 | -111 |
| | | 200 | 0.542 | -178 | 6.850 | 86 | 0.063 | 60 | 0.314 | -130 |
| | | 400 | 0.558 | 160 | 3.586 | 72 | 0.109 | 63 | 0.313 | -140 |
| | 60 | 600 | 0.602 | 145 | 2.475 | 60 | 0.151 | 62 | 0.353 | -146 |
| | | 800 | 0.619 | 134 | 1.962 | 48 | 0.190 | 59 | 0.423 | -147 |
| | | 1000 | 0.616 | 118 | 1.706 | 35 | 0.221 | 57 | 0.464 | -147 |
| | | 100 | 0.532 | -163 | 13.530 | 98 | 0.038 | 57 | 0.354 | -115 |
| | | 200 | 0.532 | 179 | 6.908 | 85 | 0.063 | 62 | 0.313 | -133 |
| | 1 | 400 | 0.558 | 159 | 3.607 | 72 | 0.111 | 64 | 0.312 | -143 |
| | 90 | 600 | 0.604 | 145 | 2.489 | 61 | 0.153 | 63 | 0.352 | -148 |
| ľ | | 800 | 0.620 | 133 | 1.982 | 48 | 0.193 | 59 | 0.419 | -149 |
| | | 1000 | 0.614 | 117 | 1.721 | 35 | 0.224 | 57 | 0.455 | -148 |
| | | 100 | 0.500 | -145 | 14.176 | 102 | 0.040 | 50 | 0.386 | -87 |
| | | 200 | 0.502 | -145 -170 | 7.358 | 87 | 0.059 | 55 | 0.304 | -105 |
| | | 400 | 0.502 | 164 | 3.819 | 71 | 0.097 | 61 | 0.304 | -118 |
| 10 | 30 | 600 | 0.559 | 149 | 2.593 | 59 | 0.133 | 62 | 0.356 | -128 |
| Í | | 800 | 0.583 | 137 | 2.033 | 46 | 0.166 | 60 | 0.442 | -134 |
| ' | | 1000 | 0.584 | 122 | 1.724 | 34 | 0.194 | 59 | 0.497 | -137 |
| Ì | | 100 | 0.487 | -154 | 14.977 | 100 | 0.037 | 55 | 0.353 | -96 |
| 1 | | 200 | 0.487 | -174 | 7.715 | 86 | 0.059 | 60 | 0.287 | -114 |
| ļ | | 400 | 0.506 | 161 | 4.009 | 72 | 0.101 | 63 | 0.294 | -125 |
| | 60 | 600 | 0.553 | 146 | 2.731 | 60 | 0.139 | 63 | 0.341 | -133 |
| j | | 800 | 0.553 | 135 | 2.158 | 47 | 0.174 | 60 | 0.422 | -137 |
| | | 1000 | 0.569 | 119 | 1.835 | 35 | 0.202 | 58 | 0.475 | -139 |
| 1 | | | 0.486 | -157 | 15.192 | 99 | . 0.036 | 57 | 0.337 | -98 |
| 1 | | 100 200 | 0.486 | -157 -176 | 7.764 | 86 | 0.058 | 61 | 0.280 | -116 |
| (| | 400 | 0.508 | 160 | 4.043 | 72 | 0.101 | 64 | 0.287 | -126 |
| \ | 90 | 600 | 0.555 | 145 | 2.761 | 60 | 0.141 | 63 | 0.336 | -134 |
| 1 | \ | 800 | 0.555 | 134 | 2.184 | 47 | 0.176 | 60 | 0.417 | -138 |
| Į. | | 1000 | 0.568 | 118 | 1.861 | 35 | 0.204 | 58 | 0.469 | -139 |
| <u> </u> | | | • | | + | 100 | 0.035 | 56 | 0.337 | -88 |
| 1 | i | 100 | 0.465 | -153 -174 | 15.774 8.091 | 100 86 | 0.035 | 56 61 | 0.337 | -88 -105 |
| ĺ | ļ | 200 400 | 0.475 0.487 | -174 161 | 4.209 | 71 | 0.097 | 64 | 0.274 | -116 |
| 15 | 30 | 600 | 0.487 | 146 | 2.863 | 59 | 0.057 | 63 | 0.237 | -126 |
| 1 | | 800 | 0.532 | 135 | 2.863 | 47 | 0.133 | 60 | 0.337 | -132 |
| [| 1 | 1000 | 0.551 | 119 | 1.909 | 34 | 0.193 | 58 | 0.423 | -135 |
| | | + | | | + | | | 54 | 0.354 | -87 |
| 1 | | 100 | 0.468 | -150 | 15.650 | 101 | 0.036 0.057 | 60 | 0.354 | -87 -104 |
| 1 | | 200 | 0.475 | -172 | 8.088 | 87 72 | 0.057 | 63 | 0.282 | -104 -116 |
| 1 | 60 | 400 600 | 0.486 | 163 147 | 4.178 2.846 | 60 | 0.096 | 63 | 0.290 | -126 |
| | | 800 | 0.530 0.549 | 136 | 2.228 | 47 | 0.133 | 60 | 0.429 | -132 |
| ł | | 1000 | 0.549 | 120 | 1,887 | 34 | 0.192_ | 59 | 0.425 | -135 |
| | - | | | | | | | | 1 | |
| | 1 | 100 | 0.487 | -141 | 14.773 | 103 | 0.039 | 50 55 | 0.391 | -80 -97 |
| l | 1 | 200 | 0.486 | -167 | 7.724 | 87 71 | 0.057 | 55 61 | | -97 -110 |
| | 90 | 400 | 0.491 | 166 | 3.986 2.694 | 59 | 0.093 0.127 | 61 62 | 0.306 0.359 | -110 -122 |
| 1 | Į. | 600 800 | 0.537 | 150 138 | 2.108 | 45 | 0.127 | 62 60 | 0.359 | -122 -129 |
| 1 | l | 1000 | 0.565 0.566 | 138 | 1.779 | 33 | 0.159 | 60 | 0.507 | -129 -134 |
| L | L | 1 1000 | 1 0.566 | 123 | 1.779 | 33 | U.185 | 90 | U.507 | -134 |

CASE 79-03, STYLE 5 TO-39 (TO-205AD)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|--------------|---------------|
| Collector-Emitter Voltage R _{BE} = 330 Ω | VCER | 25 | Vdc |
| Collector-Base Voltage | V _{CBO} | 35 | Vdc |
| Emitter-Base Voltage | VEBO | 3.5 | Vdc |
| Collector Current — Continuous | lc | 150 | mAdc |
| Total Device Dissipation @ T _A = 50°C Derate above 50°C | PD | 2.5 0.017 | Watts W/°C |
| Junction Temperature | TJ | + 175 | °C |
| Storage Temperature | T _{stq} | -65 to +200 | °C |

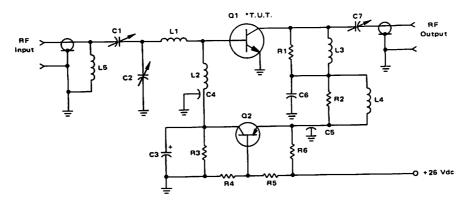
THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|--------------------------------------|--------|-----|------|
| Thermal Resistance, Junction to Case | ReJC | 60 | •cw |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|------------------|-----|-----|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 5.0 mAdc, I _B = 0) | V(BR)CEO | 20 | _ | _ | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 5.0 mAdc, RgE = 330 Ohms) | V(BR)CER | 25 | - | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.1 mA, IE = 0) | V(BR)CBO | 35 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (Ig = 0.1 mA, IC = 0) | V(BR)EBO | 3.5 | _ | _ | Vdc |
| Collector Cutoff Current (VCE = 15 Vdc, IB = 0) | ICEO | - | _ | 100 | μА |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 80 mAdc, VCE = 10 Vdc) | hFE | 60 | _ | 175 | _ |
| SMALL SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 20 Vdc, f = 200 MHz) | fT. | 2.2 | 2.5 | _ | GHz |
| Output Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | C _{obo} | | 3.0 | 4.0 | pF |
| FUNCTIONAL TEST (FIGURE 1) | | | • | | • |
| Common-Emitter Amplifier Power Gain (VCC = 26 Vdc, P _{in} = 0 dBm, f = 400 MHz) | GPE | 13 | 14 | - | dB |
| Broadband Noise Figure (VCE = 26 Vdc, f = 400 MHz) | NF | - | - | 4.0 | dB |

FIGURE 1 - 225 to 400 MHz BROADBAND TEST CIRCUIT SCHEMATIC



C1, C2 - 2.5 - 11 pF Erie Ceramic Variable

C3 - 47 µF 6.0 Volt Electrolytic

C4, C5 - 1000 pF Feedthru C6 - 470 pF Ceramic Chip

C7 - 5.5 - 18 pF Erie Caramic Variable

R1 - 150 Ω 1/8 Watt Carbon

 $R2-100~\Omega$ 1/8 Watt Carbon

R3, R4 - 10 k Ω 1/8 Watt Carbon

A5 - 3.3 kΩ 1/8 Watt Carbon

R6 - 120 Ω 1/2 Watt Carbon

L1 - 1 Turn #24, 0.125 mil ID

L2, L4 - 0.47 µH Molded Choke

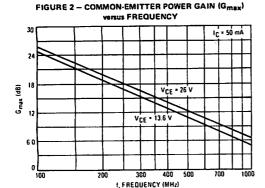
L3 - 2 Turns #24, 0.125 mil ID L5 - 4 Turns #24, 0.125 mil ID

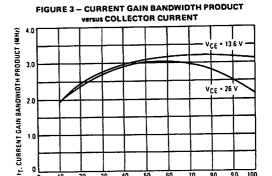
Q2 - 2N2907A

10

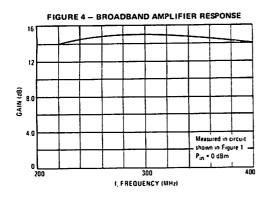
*Transistor Under Test

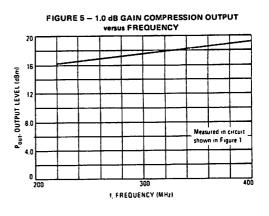
IE = 47 mAdc (Nominal)

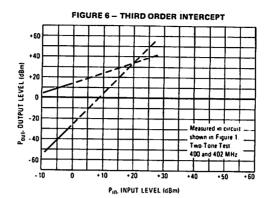




IC, COLLECTOR CURRENT (mA)







S-PARAMETERS

| S-PARAMETERS | | | | | | | | | | |
|--------------|------|-----------|-------|-------------|--------|-----|-------|----|-------|-----|
| VCE | lc. | Frequency | | S11 S21 S12 | | | | | | 2 |
| (Volts) | (mA) | (MHz) | IS11I | 44 | IS21i | | IS12I | 4 | IS22i | Lφ |
| | | 100 | 0.388 | -111 | 12.318 | 107 | 0.032 | 61 | 0.597 | -24 |
| 1 | | 200 | 0.331 | -151 | 6.768 | 88 | 0.049 | 68 | 0.480 | -25 |
| 13.6 | 10 | 300 | 0.337 | -171 | 4.650 | 77 | 0.072 | 73 | 0.443 | -31 |
| 1 1 | | 400 | 0.344 | 176 | 3.580 | 68 | 0.096 | 78 | 0.442 | -40 |
| l l | | 500 | 0.349 | 166 | 2.889 | 59 | 0.125 | 80 | 0.459 | -47 |
| 1 1 | | 100 | 0.287 | -125 | 14.160 | 103 | 0.030 | 67 | 0.516 | -24 |
| | | 200 | 0.263 | -160 | 7.585 | 86 | 0.053 | 73 | 0.414 | -23 |
| | 20 | 300 | 0.275 | -177 | 5.167 | 76 | 0.078 | 76 | 0.378 | -30 |
| 1 1 | | 400 | 0.288 | 172 | 3.968 | 68 | 0.104 | 77 | 0.378 | -38 |
| | | 500 | 0.293 | 164 | 3.214 | 60 | 0.135 | 78 | 0.396 | -45 |
| [[| | 100 | 0.206 | -140 | 15.745 | 99 | 0.029 | 74 | 0.446 | -24 |
| | | 200 | 0.208 | ~171 | 8.299 | 84 | 0.056 | 76 | 0.358 | -21 |
| 1 | 50 | 300 | 0.226 | 176 | 5.612 | 75 | 0.084 | 76 | 0.324 | -27 |
| 1 1 | | 400 | 0.235 | 169 | 4.307 | 68 | 0.113 | 77 | 0.326 | -36 |
| 1 1 | | 500 | 0.243 | 161 | 3.488 | 60 | 0.114 | 76 | 0.345 | -42 |
| l i | | 100 | 0.179 | -151 | 15.931 | 98 | 0.029 | 77 | 0.430 | -22 |
| | | 200 | 0.187 | -177 | 8.293 | 85 | 0.058 | 80 | 0.358 | -19 |
| | 100 | 300 | 0.203 | 171 | 5.626 | 77 | 0.087 | 80 | 0.330 | -25 |
| 1 | | 400 | 0.212 | 164 | 4.276 | 70 | 0.115 | 80 | 0.338 | -33 |
| | | 500 | 0.213 | 157 | 3.456 | 63 | 0.147 | 79 | 0.364 | -39 |
| [[| | 100 | 0.454 | -100 | 13.580 | 105 | 0.027 | 58 | 0.625 | -15 |
| | | 200 | 0.313 | -138 | 7.339 | 88 | 0.040 | 67 | 0.552 | -17 |
| 26 | 10 | 300 | 0.291 | -161 | 4.989 | 78 | 0.060 | 76 | 0.532 | -23 |
| 1 1 | | 400 | 0.287 | -175 | 3.826 | 70 | 0.080 | 84 | 0.544 | -30 |
| l | | 500 | 0.287 | 173 | 3.096 | 63 | 0.106 | 89 | 0.570 | -36 |
| | | 100 | 0.313 | -105 | 15.191 | 102 | 0.025 | 62 | 0.566 | -14 |
| l | | 200 | 0.220 | -144 | 8.086 | 87 | 0.044 | 73 | 0.509 | -15 |
| | 20 | 300 | 0.213 | -166 | 5.487 | 77 | 0.067 | 78 | 0.489 | -20 |
| | | 400 | 0.215 | -178 | 4.204 | 71 | 0.092 | 83 | 0.498 | -28 |
| [| | 500 | 0.214 | 170 | 3.404 | 64 | 0.116 | 86 | 0.523 | -34 |
| Γ | - 1 | 100 | 0.165 | -117 | 16.375 | 102 | 0.026 | 71 | 0.529 | -14 |
| 1 | | 200 | 0.139 | -157 | 8.695 | 87 | 0.048 | 78 | 0.471 | -14 |
| l | 50 | 300 | 0.151 | -176 | 5.882 | 78 | 0.073 | 80 | 0.449 | -20 |
| | | 400 | 0.157 | 173 | 4.494 | 71 | 0.098 | 82 | 0.458 | -27 |
| <u>[</u> | | 500 | 0.158 | 164 | 3.659 | 65 | 0.124 | 84 | 0.485 | -32 |
| [| T | 100 | 0.215 | -147 | 13.156 | 103 | 0.023 | 72 | 0.602 | -14 |
| 1 | | 200 | 0.212 | -176 | 7.220 | 88 | 0.044 | 82 | 0.536 | -17 |
| j | 100 | 300 | 0.222 | 171 | 4.951 | 79 | 0.069 | 84 | 0.507 | -24 |
| } | 1 | 400 | 0.230 | 164 | 3.851 | 72 | 0.093 | 87 | 0.513 | -31 |
| | | 500 | 0.233 | 156 | 3.123 | 64 | 0.123 | 89 | 0.534 | -36 |

Unit

MRF531

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

HIGH FREQUENCY TRANSISTOR

Typ

Max

4.0

9.0

ρF

рF

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 100 | Vdc |
| Collector-Base Voltage | VCBO | 100 | Vdc |
| Emitter-Base Voltage | VEBO | 3.5 | Vdc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.5 14.3 | Watts mW/°C |
| Storage Temperature | T _{stq} | -65 to +200 | °C |

THERMAL CHARACTERISTICS

| Characteristic | | Symbol | Max | Unit |
|----------------|--------------------------------------|--------|-----|------|
| | Thermal Resistance, Junction to Case | ReJC | 70 | °C/W |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

Characteristic

OFF CHARACTERISTICS Vdc V(BR)CEO 100 Collector-Emitter Breakdown Voltage (IC = 10 mAdc, IB = 0) 100 Vdc V(BR)CBO Collector-Base Breakdown Voltage (IC = 0.1 mAdc, IE = 0) Vdc V(BR)EBO 3.5 Emitter-Base Breakdown Voltage $(l_E = 0.1 \text{ mAdc, } l_C = 0)$ 10 μAdc ICES **Collector Cutoff Current** (VCE = 75 Vdc, VBE = 0) ON CHARACTERISTICS hFE 25 **DC Current Gain** (IC = 5.0 mAdc, VCE = 10 Vdc) 1.0 Vdc V_{CE(sat)} Collector-Emitter Saturation Voltage (Ic = 10 mAdc, IB = 1.0 mAdc) SMALL SIGNAL CHARACTERISTICS Current-Gain — Bandwidth Product fT 500 800 MHz (IC = 50 mAdc, VCE = 25 Vdc, f = 100 MHz)

Symbol

Cobo

Cibo

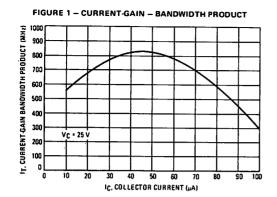
Min

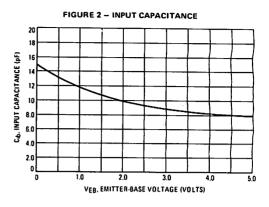
Output Capacitance

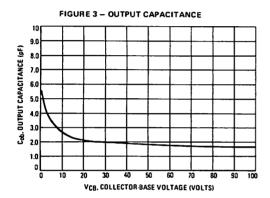
Input Capacitance

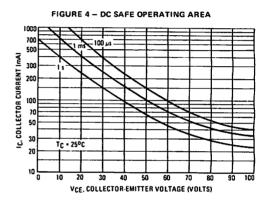
(VCB = 10 Vdc, IE = 0, f = 1.0 MHz)

(VBE = 3.0 Vdc, IC = 0, f = 1.0 MHz)









CASE 79-02, STYLE 1 TO-39 (TO-205AD)

HIGH FREQUENCY TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 80 | Volts |
| Collector-Base Voltage | VCBO | 80 | Volts |
| Emitter-Base Voltage | VEBO | 3.5 | Volts |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.5 14.3 | Watts mW/°C |
| Storage Temperature | T _{sta} | -60 to +200 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|--------------------------------------|-------------------|-----|------|
| Thermal Resistance, Junction to Case | R _Ø JC | 70 | °C/W |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Max | Unit |
|---|----------------------|-----|-----|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 10 mA) | V(BR)CEO | 80 | - | Vdc |
| Collector-Base Breakdown Voltage (I _C = 0.1 mA) | V(BR)CBO | 80 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 0.1 mA) | V(BR)EBO | 3.5 | - | Vdc |
| Collector Cutoff Current (VCE = 75 V) | ICES | _ | 10 | μAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 5.0 mA, V _{CE} = 10 V) | hFE | 25 | - | _ |
| Collector-Emitter Saturation Voltage (I _C = 10 mA, I _B = 1.0 mA) | V _{CE(sat)} | | 1.0 | Vdc |
| SMALL SIGNAL CHARACTERISTICS | | | | |
| Current-Gain — Bandwidth Product (I _C = 50 mA, V _{CE} = 25 V, f = 100 MHz) | fī | 500 | - | MHz |
| Output Capacitance (VCB = 10 V, f = 1.0 MHz) | C _{obo} | _ | 4.0 | pF |

MRF534, MRF536 For Specifications, See MM4049 Data.

CASE 317-01, STYLE 2

HIGH FREQUENCY TRANSISTOR

NPN SILICON

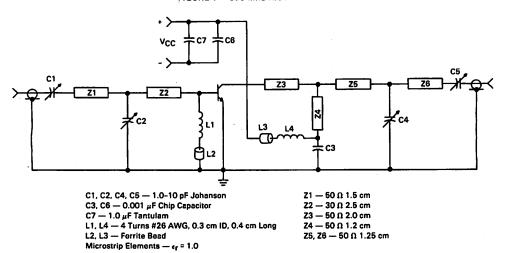
MAXIMUM RATINGS

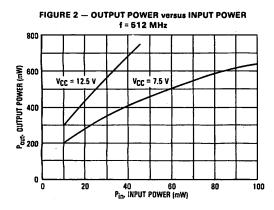
| Rating | Symbol | Value | Unit |
|---|------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 18 | Vdc |
| Collector-Base Voltage | V _{CBO} | 36 | Vdc |
| Emitter-Base Voltage | V _{EBO} | 3.0 | Vdc |
| Collector Current — Continuous | 1C | 150 | mAdc |
| Total Device Dissipation @ T _C = 50°C Derate above 50°C | PD | 2.0 20 | Watts mW/°C |
| Storage Temperature | T _{sto} | -65 to +150 | •€ |

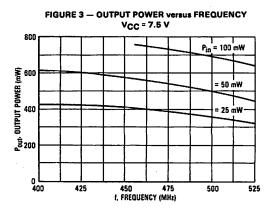
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

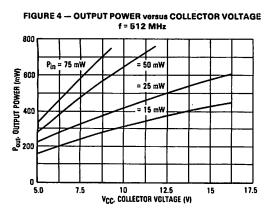
| Characteristic | | Symbol | Min | Тур | Max | Unit |
|--|----------------------------|----------|---------|-----------|-----|------|
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 5.0 mAdc, IB = 0) | - | V(BR)CEO | 18 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage ($I_C = 100 \mu Adc, I_E = 0$) | | V(BR)CBO | 36 | | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 μ Adc, IC = 0) | | V(BR)EBO | 3.0 | - | _ | Vdc |
| Collector Cutoff Current (VCE = 15 Vdc, VBE = 0) | | ICES | | - | 1.0 | mAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain (IC = 50 mAdc, VCE = 10 Vdc) | | pŁE | 30 | 90 | 200 | _ |
| SMALL SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product (IC = 100 mAdc, VCE = 10 Vdc, f = 200 MHz) | | fT | | 3000 | _ | MHz |
| Output Capacitance (VCB = 12.5 Vdc, IE = 0, f = 1.0 MHz) | | Cobo | | 2.0 | 2.5 | pF |
| FUNCTIONAL TEST | | • | | | • | |
| Common-Emitter Amplifier Power Gain (Figure 1) (V _{CC} = 12.5 Vdc, P _{Out} = 0.5 W) | f = 870 MHz f = 512 MHz | GpE | 8.0 | 9.5 13 | = | dB |
| Collector Efficiency (Figure 1) (V _{CC} = 12.5 Vdc, P _{Out} = 0.5 W) | f = 870 MHz f = 512 MHz | η | 50 — | 65 60 | = | % |
| TYPICAL PERFORMANCE @ V _{CC} = 7.5 V | | | _ | | | |
| Common-Emitter Amplifier Power Gain (V _{CC} = 7.5 Vdc, P _{out} = 0.5 W) | f = 870 MHz f = 512 MHz | GPE | _ | 6.5 10 | = | dB |
| Collector Efficiency (V _{CC} = 7.5 Vdc, P _{out} = 0.5 W) | f = 870 MHz f = 512 MHz | η | _ | 70 65 | = | % |

FIGURE 1 - 870 MHz TEST FIXTURE









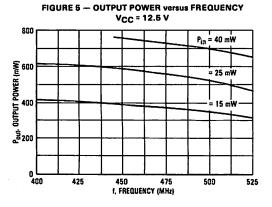
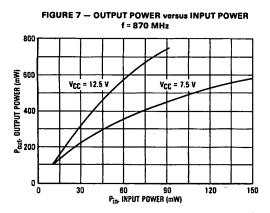


FIGURE 6 - Z $_{in}$ AND Z $_{OL}$ versus COLLECTOR VOLTAGE, INPUT POWER, AND OUTPUT POWER

| f EREQUENCY | | Z _{in} OHMS | | Z _{OL} * OHMS | | | | | | | |
|------------------|------------------------------|-------------------------|------------|---------------------------|-------------------------|-----------|----------|--------------------------|----------|--|--|
| FREQUENCY MHz | V _{CC} = 7.5-12.5 V | | | | V _{CC} = 7.5 V | | | V _{CC} = 12.5 V | | | |
| | 15 mW | 25 mW | 50 mW | 0.25 W | 0.60 W | 0.75 W | 0.25 W | 0.50 W | 0.75 W | | |
| 400 | 4.3 - j13.3 | 4.9 - j11.0 | 5.7 - j8.7 | 31 - j49 | 44 - j34 | 42 - j4.9 | 20 - j68 | 42 - j60 | 52 - j54 | | |
| 440 | 3.9 - j8.8 | 4.5 - j8.7 | 5.4 - j6.9 | 27 - j42 | 39 - j30 | 40 - j6.9 | 19 - j62 | 37 - j54 | 49 - j50 | | |
| 480 | 3.5 - j4.4 | 4.1 - j6.5 | 5.0 - j4.3 | 24 - j36 | 36 - j25 | 39 - j9.0 | 18 - j56 | 33 - j48 | 47 - j46 | | |
| 520 | 3.2 - j2.2 | 3.8 - j4.3 | 4.7 - j1.7 | 22 - j30 | 34 - j20 | 37 - j12 | 17 - j52 | 31 - j44 | 47 - j42 | | |

^{*}Z_{QL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.



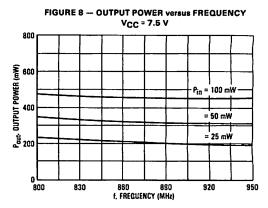


FIGURE 9 — OUTPUT POWER versus COLLECTOR VOLTAGE
f = 870 MHz

800
Pin = 100 mW

= 50 mW

= 25 mW

VCC COLLECTOR VOLTAGE (V)

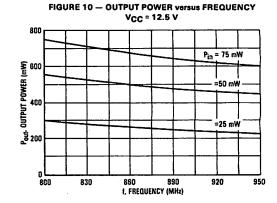
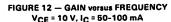


FIGURE 11 - Z $_{in}$ AND Z $_{OL}$ versus COLLECTOR VOLTAGE, INPUT POWER, AND OUTPUT POWER

| 1 | Z _{in} OHMS | | | | Z _{OL} * | | | | | | |
|------------------|-------------------------|------------------------------|-------------|--------------|-------------------------|--------------|--------------|--------------------------|--------------|--|--|
| FREQUENCY MHz | ٧c | V _{CC} = 7.5-12.5 V | | | V _{CC} = 7.5 V | | | V _{CC} = 12.5 V | | | |
| | 25 mW | 50 mW | 100 mW | 0.25 W | 0.50 W | 0.75 W | 0.25 W | 0.50 W | 0.75 W | | |
| 800 | 2.9 + j2.2 | 3.8 + j4.4 | 4.7 + j6.5 | 15.0 - j36.8 | 22.7 - j30.6 | 27.1 - j22.6 | 14.6 - j43.6 | 17.2 - j39.7 | 23.4 - j37.7 | | |
| 850 | 3.2 + j3.5 | 3.8 + j5.2 | 4.8 + j7.4 | 15.7 - j35.3 | 23.9 - j28.7 | 27.3 - j21.5 | 16.3 - j40.8 | 17.8 – j39.5 | 23.7 - j36.8 | | |
| 900 | 3.8 + j5.7 | 4.4 + j7.0 | 5.4 + j8.7 | 16.4 – j33.7 | 25.1 - j27.0 | 27.5 - j20.5 | 17.3 - j38.2 | 18.3 - j39.3 | 23.9 - j36.0 | | |
| 950 | 4.1 + j7.4 | 4.5 + j8.8 | 5.5 + j10.1 | 17.0 - j32.2 | 26.3 - j25.2 | 27.6 - j19.4 | 17.2 - j36.1 | 20.1 - j38.5 | 24.5 - j35.6 | | |

^{*}Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.



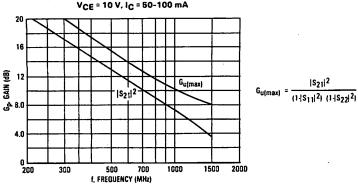


FIGURE 13 — GAIN versus COLLECTOR CURRENT

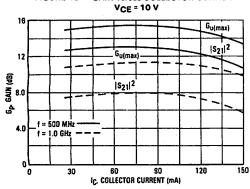


FIGURE 14 — NOISE FIGURE AND ASSOCIATED GAIN

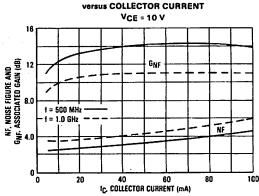


FIGURE 15 — CURRENT GAIN BANDWIDTH PRODUCT versus COLLECTOR CURRENT

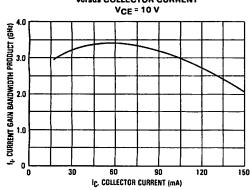


FIGURE 16 — OUTPUT CAPACITANCE VOISUS
COLLECTOR BASE VOLTAGE

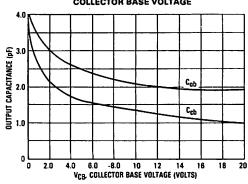


FIGURE 17 — COMMON EMITTER SCATTERING PARAMETERS

| · · · · · · · · · · · · · · · · · · · | | | | | | | ARAMETER | | S ₂₂ | | |
|---------------------------------------|---------|-------|----------------|------|-------|------------|------------------|------------|-----------------|------------|--|
| VCE | 'C, | f | S ₁ | | | 21 | S ₁ | | | | |
| (Volts) | (mA) | (MHz) | IS11I | Lφ | IS21I | ζ φ | IS ₁₂ | Δ φ | S22 | Δ φ | |
| 5.0 | 10 | 250 | 0.72 | -161 | 6.20 | 93 | 0.057 | 30 | 0.30 | -91 | |
| | ļ | 500 | 0.73 | 179 | 3.16 | 76 | 0.069 | 43 | 0.27 | -94 | |
| 1 | ŀ | 1000 | 0.76 | 158 | 1.62 | 55 | 0.105 | 63 | 0.27 | -119 | |
| 1 | | 1500 | 0.82 | 142 | 1.08 | 41 | 0.155 | 70 | 0.41 | -137 | |
| , | 25 | 250 | 0.70 | -173 | 7.17 | 89 | 0.045 | 47 | 0.26 | -123 | |
| | | 500 | 0.70 | 172 | 3.63 | 75 | 0.073 | 60 | 0.20 | -128 | |
| | 1 | 1000 | 0.74 | 152 | 1.90 | 54 | 0.134 | 67 | 0.21 | -157 | |
| | <u></u> | 1500 | 0.79 | 136 | 1.32 | 39 | 0.196 | 66 | 0.32 | -167 | |
| | 50 | 250 | 0.72 | -178 | 7.63 | 89 | 0.038 | 56 | 0.27 | -139 | |
| | | 500 | 0.72 | 170 | 3.85 | 77 | 0068 | 67 | 0.23 | -141 | |
| | | 1000 | 0.75 | 153 | 2.01 | 59 | 0.129 | 72 | 0.23 | -162 | |
| | | 1500 | 0.81 | 137 | 1.40 | 46 | 0.188 | 70 | 0.32 | -164 | |
| | 100 | 250 | 0.73 | 179 | 7.34 | 88 | 0.036 | 61 | 0.26 | -143 | |
| | | 500 | 0.74 | 169 | 3.70 | 77 | 0.067 | 71 | 0.22 | -144 | |
| l i | | 1000 | 0.76 | 153 | 1.94 | 59 | 0.130 | 74 | 0.24 | -166 | |
| ì ' | | 1500 | 0.81 | 138 | 1.36 | 46 | 0.191 | 71 | 0.32 | -167 | |
| | 150 | 250 | 0.78 | 176 | 5.19 | 92 | 0.033 | 64 | 0.22 | -131 | |
| | , , , | 500 | 0.78 | 167 | 2.76 | 78 | 0.065 | 74 | 0.21 | -131 | |
| | 1 | 1000 | 0.80 | 151 | 1.49 | 58 | 0.129 | 77 | 0.24 | -155 | |
| 1 | l | 1500 | 0.85 | 135 | 1.05 | 45 | 0.191 | 73 | 0.35 | -161 | |
| 10 | 10 | 250 | 0.69 | -157 | 7.03 | 94 | 0.050 | 33 | 0.34 | -67 | |
| | | 500 | 0.70 | -178 | 3.59 | 77 | 0.060 | 46 | 0.32 | -69 | |
| | | 1000 | 0.74 | 160 | 1.84 | 55 | 0.094 | 67 | 0.29 | -94 | |
| | | 1500 | 0.81 | 142 | 1.20 | 41 | 0.148 | 76 | 0.42 | -121 | |
| 1 | 25 | 250 | 0.67 | -168 | 8.30 | 91 | 0.039 | 46 | 0.24 | -93 | |
| | | 500 | 0.68 | 176 | 4.25 | 77 | 0.060 | 60 | 0.21 | -89 | |
| |] | 1000 | 0.72 | 158 | 2.19 | 57 | 0.109 | 71 | 0.19 | -114 | |
| | | 1500 | 0.78 | 142 | 1.47 | 44 | 0.165 | 74 | 0.31 | -134 | |
| | 50 | 250 | 0.68 | -174 | 8.88 | 90 | 0.035 | 55 | 0.21 | -110 | |
| ł | | 500 | 0.68 | 172 | 4.49 | 77 | 0.060 | 67 | 0.18 | -104 | |
| 1 | | 1000 | 0.72 | 155 | 2.31 | 59 | 0.113 | 74 | 0.17 | -128 | |
| i | i | 1500 | 0.77 | 139 | 1.58 | 46 | 0.169 | 74 | 0.28 | -140 | |
| 1 | 100 | 250 | 0.68 | -178 | 8.49 | 89 | 0.03 | 61 | 0.19 | -104 | |
| ! | 1 | 500 | 0.69 | 170 | 4.32 | 76 | 0.06 | 71 | 0.17 | -97 | |
| | | 1000 | 0.72 | 153 | 2.25 | 58 | 0.12 | 76 | 0.17 | -123 | |
| 1 | 1 | 1500 | 0.78 | 137 | 1.53 | 44 | 0.18 | 75 | 0.28 | -137 | |
| l | 150 | 250 | 0.72 | 178 | 6.53 | 91 | 0.029 | 64 | 0.22 | -71 | |
| | '30 | 500 | 0.73 | 169 | 3.37 | 77 | 0.056 | 75 | 0.24 | -75 | |
| | | 1000 | 0.76 | 152 | 1.79 | 57 | 0.112 | 80 | 0.22 | -105 | |
| 1 | | 1500 | 0.83 | 137 | 1.22 | 43 | 0.175 | 79 | 0.34 | -129 | |
| | | | | | | | | | | | |

FIGURE 18 - TUNABLE TEST FIXTURE

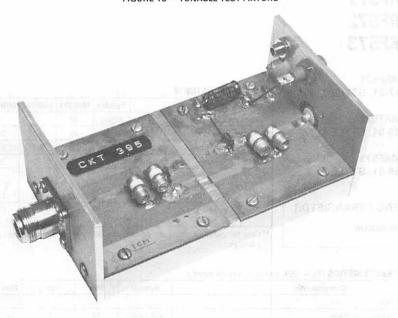
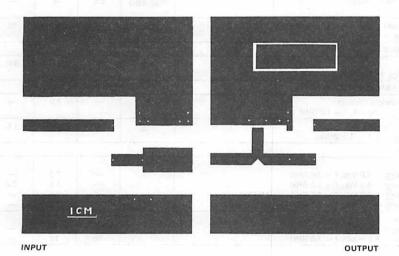


FIGURE 19 — PRINTED CIRCUIT BOARD LAYOUT



MRF571 MRF572 MRF573

MRF571 CASE 317-01, STYLE 2

MRF572 CASE 303-01, STYLE 1

MRF573 CASE 358-01, STYLE 1

HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | MRF571 | MRF572 | MRF573 | Unit |
|---|------------------|----------------|----------------|------------------|----------------|
| Collector-Emitter Voltage | VCEO | 10 | 10 | 10 | Vdc |
| Collector-Base Voltage | VCBO | 20 | 20 | 20 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | 3.0 | 3.0 | Vdc |
| Collector Current — Continuous | lc | 70 | 70 | 70 | mAdc |
| Total Device Dissipation @ T _C = 100°C(1) Derate above 100°C | PD | 0.5 5.0 | 0.75 7.5 | 0.75 7.5 | Watts mW/°C |
| Storage Temperature | T _{stg} | -65 to +150 | -65 to +200 | - 65 to + 200 | °C |

⁽¹⁾ Case temperature measured on collector lead immediately adjacent to body of package.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|-----------------|-------------|--------------------------|----------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 0.1 mAdc, IB = 0) | V(BR)CEO | 10 | 12 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 1.0 mAdc, I _E = 0) | V(BR)CBO | 20 | 1 | - | Vdc |
| Emitter-Base Breakdown Voltage (IE = 50 µAdc, IC = 0) | V(BR)EBO | 2.5 | ı | _ | Vdc |
| Collector Cutoff Current (VCB = 8.0 Vdc, Ig = 0) | ІСВО | · - | 1 | . 10 | μAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 30 mAdc, VCE = 5.0 Vdc) | hFE | 50 | _ | 300 | _ |
| SMALL SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bendwidth Product (VCE = 8.0 VDC, IC = 50 mA, f = 1.0 GHz) | fT | _ | 8.0 | _ | GHz |
| Collector-Base Capacitance (VCB = 6.0 Vdc, IE = 0, f = 1.0 MHz) | C _{cb} | _ | .7 | 1.0 | pF |
| FUNCTIONAL TEST | | | | | |
| Noise Figure (I _C = 5.0 mAdc, V _{CE} = 6.0 Vdc, f = .50 GHz) (I _C = 5.0 mAdc, V _{CE} = 6.0 Vdc, f = 1.0 GHz) (I _C = 5.0 mAdc, V _{CE} = 6.0 Vdc, f = 2.0 GHz) (I _C = 5.0 mAdc, V _{CE} = 6.0 Vdc, f = 2.0 GHz) MRF571 (I _C = 5.0 mAdc, V _{CE} = 6.0 Vdc, f = 2.0 GHz) | NF | _ _ _ | 1.0 1.5 2.8 2.5 | 2.0 — | dB |
| Gain @ Noise Figure (VCE = 6.0 Vdc, IC = 5.0 mAdc, f = .50 GHz) (VCE = 6.0 Vdc, IC = 5.0 mAdc, f = 1.0 GHz) | GNF | <u> </u> | 16.5 12 | = | d₿ |

FIGURE 1 — C_{cb}, COLLECTOR-BASE CAPACITANCE versus VOLTAGE

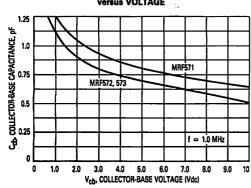


FIGURE 2 — Cib, INPUT CAPACITANCE
Versus EMITTER BASE VOLTAGE

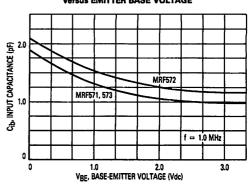


FIGURE 3 — MRF671 — GAIN AT NOISE FIGURE AND NOISE FIGURE Versus FREQUENCY

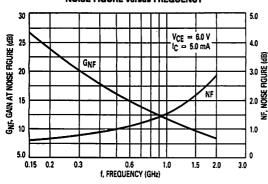


FIGURE 4 — MRF572, MRF573 — GAIN AT NOISE FIGURE AND NOISE FIGURE versus FREQUENCY

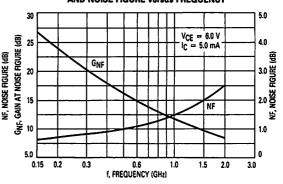


FIGURE 5 — MRF671, MRF672 and MRF673 — GAIN AT NOISE FIGURE AND NOISE FIGURE versus COLLECTOR CURRENT

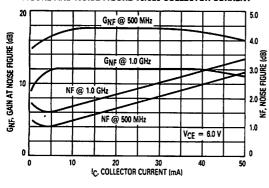


FIGURE 6 — f_Y, CURRENT GAIN-BANDWIDTH PRODUCT

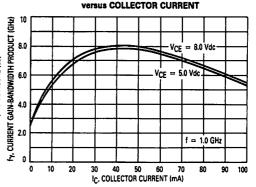


FIGURE 7 — GA MAX, MAXIMUM AVAILABLE GAIN
Versus FREQUENCY

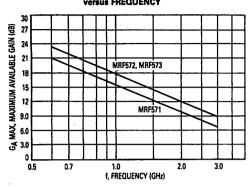


FIGURE 8 — 1.0 dB COMPRESSION PT.

AND THIRD ORDER INTERCEPT

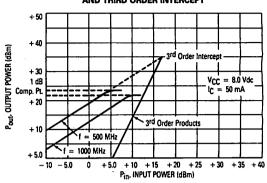


FIGURE 9 — MRF571 — G $_{\rm U}$ max and $|{\rm S}_{21}|^2$

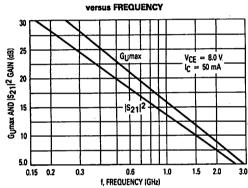
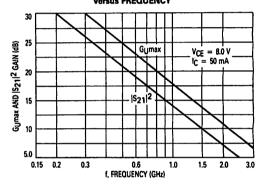


FIGURE 10 — MRF572, MRF573 — Gymax and |S₂₁|² versus FREQUENCY

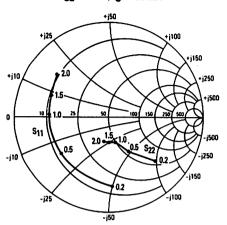


MRF571 • MRF572 • MRF573

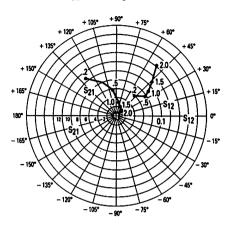
MRF571
INPUT/OUTPUT REFLECTION COEFFICIENTS

Versus FREQUENCY (GHz)

VCE = 6.0 V, IC = 5.0 mA



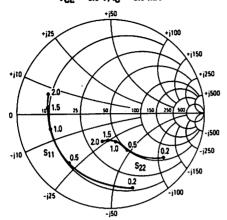
MRF571
FORWARD/REVERSE TRANSMISSION
CCEFFICIENTS Versus FREQUENCY (GHz)
VCE = 6.0 V, IC = 5.0 mA



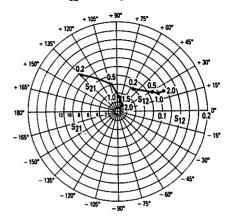
MRF571 COMMON EMITTER S-PARAMETERS

| VCE | lc | f | S | 11 | 8 | 21_ | S | 12 | S ₂₂ | |
|---------|------|-------|-----------------|--------------|-----------------|-----|-----------------|------------|-----------------|-------|
| (Volts) | (mA) | (MHz) | S ₁₁ | Δ φ | S ₂₁ | 44 | S ₁₂ | Δ φ | S ₂₂ | 4 |
| 6.0 | 5.0 | 200 | 0.74 | -86 | 10.5 | 129 | 0.06 | 48 | 0.69 | -42 |
| () | | 500 | 0.62 | -143 | 5.5 | 97 | 0.08 | 33 | 0.41 | -59 |
| | | 1000 | 0.61 | 178 | 3.0 | 78 | 0.09 | 37 | 0.28 | -69 |
| | | 1500 | 0.65 | 158 | 2.0 | 62 | 0.11 | 44 | 0.26 | -88 |
| | | 2000 | 0.70 | 140 | 1.6 | 51 | 0.14 | 51 | 0.27 | -99 |
| 1 | 10 | 200 | 0.64 | -111 | 15 | 118 | 0.04 | 44 | 0.53 | -59 |
| 1 | | 500 | 0.58 | - 160 | 6.9 | 93 | 0.06 | 42 | 0.27 | -77 |
| 1 | | 1000 | 0.59 | 168 | 3.7 | 77 | 0.09 | 52 | 0.16 | -91 |
| ۱ ۱ | | 1500 | 0.63 | 151 | 2.5 | 64 | 0.12 | 56 | 0.16 | -113 |
| | | 2000 | 0.67 | 134 | 2.0 | 53 | 0.16 | 57 | 0.16 | -118 |
| | 50 | 200 | 0.56 | -160 | 20.4 | 102 | 0.02 | 57 | 0.27 | -98 |
| 1 | | 500 | 0.57 | 176 | 8.4 | 86 | 0.05 | 67 | 0.14 | - 130 |
| l ! | | 1000 | 0.60 | 156 | 4.4 | 75 | 0.09 | 70 | 0.11 | - 164 |
| | l i | 1500 | 0.62 | 152 | 2.9 | 64 | 0.13 | 68 | 0.13 | - 175 |
| | | 2000 | 0.66 | 127 | 2.4 | 53 | 0.18 | 62 | 0.11 | - 178 |
| 8.0 | 5.0 | 200 | 0.75 | -83 | 10.7 | 129 | 0.06 | 49 | 0.71 | -39 |
| | | 500 | 0.62 | – 140 | 5.1 | 98 | 0.08 | 34 | 0.43 | -54 |
| | | 1000 | 0.60 | - 179 | 3.7 | 78 | 0.09 | 38 | 0.31 | -62 |
| | | 1500 | 0.64 | 159 | 2.1 | 62 | 0.10 | 45 | 0.29 | -80 |
| | | 2000 | 0.69 | 141 | 1.7 | 52 | 0.13 | 52 | 0.29 | -91 |
| 1 | 10 | 200 | 0.64 | -99 | 15.1 | 120 | 0.05 | 46 | 0.54 | -60 |
| 1 | | 500 | 0.52 | - 152 | 7.1 | 94 | 0.07 | 45 | 0.32 | -75 |
| J | | 1000 | 0.52 | 170 | 3.7 | 76 | 0.10 | 54 | 0.15 | -82 |
| | | 1500 | 0.52 | 150 | 2.5 | 62 | 0.13 | 56 | 0.16 | - 108 |
| | | 2000 | 0.57 | 133 | 2.0 | 51 | 0.18 | '55 | 0.16 | - 107 |
| | 50 | 200 | 0.52 | - 153 | 19.6 | 102 | 0.03 | 56 | 0.28 | -92 |
| | - 1 | 500 | 0.52 | 178 | 8.1 | 88 | 0.05 | 67 | 0.16 | -98 |
| | | 1000 | 0.56 | 157 | 4.1 | 73 | 0.10 | · 70 | 0.06 | - 130 |
| i | | 1500 | 0.54 | 139 | 2.8 | 62 | 0.13 | 68 | 0.11 | 146 |
| | | 2000 | 0.59 | 126 | 2.2 | 52 | 0.19 | 63 | 0.10 | - 137 |

MRF572 INPUT/OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY (GHz) VCE = 8.0 V, IC = 5.0 mA



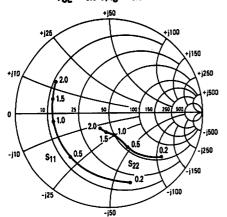
MRF572 FORWARD/REVERSE COEFFICIENTS Versus FREQUENCY (GHz) VCE = 6.0 V, IC = 5.0 mA



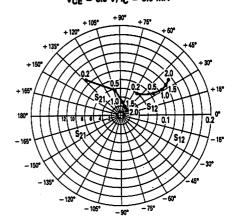
MRF572 COMMON EMITTER S-PARAMETERS

| Von | J ₀ | f (MHz) | S ₁₁ | | S | S ₂₁ | | S ₁₂ | | S ₂₂ | |
|----------------------------|----------------|------------|-----------------|------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|--|
| V _{CE} (Volts) | (mA) | | 511 | 4 φ | S ₂₁ | ۷ | S ₁₂ | ۷ φ | S ₂₂ | ۷ф_ | |
| 6.0 | 5.0 | 200 | 0.81 | -73 | 10.9 | 134 | 0.06 | 50 | 0.74 | -40 | |
| 0.0 | "" | 500 | 0.68 | - 130 | 6.1 | 102 | 0.09 | 29 | 0.43 | -64 | |
| | 1 1 | 1000 | 0.66 | - 167 | 3.3 | 79 | 0.10 | 22 | 0.29 | -77 | |
| | | 1500 | 0.66 | 174 | 2.3 | 63 | 0.10 | 22 | 0.27 | - 94 | |
| | | 2000 | 0.68 | 161 | 1.8 | 49 | 0.11 | 23 | 0.29 | - 104 | |
| | 10 | 200 | 0.72 | -101 | 15.9 | 123 | 0.05 | 43 | 0.57 | - 58 | |
| 1 | '- | 500 | 0.66 | 150 | 7.7 | 95 | 0.06 | 30 | 0.29 | -86 | |
| | | 1000 | 0.66 | - 178 | 4.0 | 77 | 0.08 | 33 | 0.19 | - 103 | |
| 1 | • | 1500 | 0.67 | 166 | 2.7 | 63 | 0.09 | 36 | 0.19 | - 122 | |
| | | 2000 | 0.69 | 155 | 2.1 | 51 | 0.10 | 37 | 0.20 | - 129 | |
| | 50 | 200 | 0.67 | - 154 | 21.8 | 104 | 0.02 | 43 | 0.30 | -94 | |
| | " | 500 | 0.68 | - 177 | 9.0 | 87 | 0.03 | 52 | 0.17 | - 129 | |
| | l | 1000 | 0.70 | 167 | 4.5 | 74 | 0.06 | 58 | 0.14 | - 151 | |
| l . | | 1500 | 0.71 | 157 | 3.0 | 62 | 0.08 | 59 | 0.16 | - 160 | |
| l | | 2000 | 0.73 | 148 | 2.3 | 51 | 0.10 | 55 | 0.17 | - 161 | |
| 8.0 | 5.0 | 200 | 0.83 | -69 | 10.9 | 136 | 0.06 | 52 | 0.75 | - 36 | |
| | | 500 | 0.71 | - 125 | 6.3 | 103 | 0.08 | 30 | 0.46 | -57 | |
| | | 1000 | 0.64 | - 164 | 3.5 | 80 | 0.09 | 24 | 0.31 | -68 | |
| l | | 1500 | 0.65 | 176 | 2.4 | 63 | 0.10 | 23 | 0.29 | -84 | |
| l | İ | 2000 | 0.66 | 163 | 1.8 | 49 | 0.11 | 24 | 0.30 | -94 | |
| 1 | 10 | 200 | 0.74 | - 94 | 16.2 | 125 | 0.05 | 45 | 0.60 | -51 | |
| 1 | " | 500 | 0.65 | - 146 | 7.9 | 96 | 0.06 | 32 | 0.31 | -74 | |
| 1 | 1 | 1000 | 0.64 | - 176 | 4.2 | 77 | 0.07 | 33 | 0.20 | -87 | |
| 1 | ì | 1500 | 0.65 | 168 | 2.8 | 63 | 0.09 | 36 | 0.19 | - 104 | |
| ł | 1 | 2000 | 0.67 | 156 | 2.2 | 50 | 0.10 | 37 | 0.20 | -111 | |
| 1 | 50 | 200 | 0.62 | - 150 | 22.7 | 104 | 0.02 | 43 | 0.30 | -81 | |
| 1 . | 1 | 500 | 0.64 | - 174 | 9.4 | 86 | 0.03 | 51 | 0.15 | -107 | |
| | 1 | 1000 | 0.68 | 167 | 4.8 | 74 | 0.05 | 58 | 0.10 | -126 | |
| | 1 | 1500 | 0.69 | 160 | 3.2 | 61 | 0.07 | 58 | 0.13 | -140 | |
| 1 | 1 | 2000 | 0.70 | 147 | 2.4 | 50 | 0.09 | 55 | 0.15 | - 140 | |

MRF873
(NPUT/OUTPUT REFLECTION
COEFFICIENTS versus FREQUENCY (GHz)
VCE = 6.0 V, IC = 5.0 mA



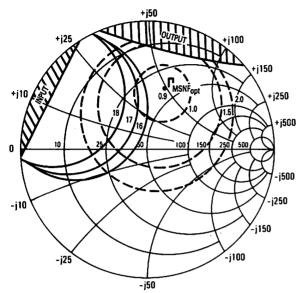
MRF573 FORWARD/REVERSE COEFFICIENTS Versus FREQUENCY (GHz) VCE = 6.0 V, IC = 5.0 mA



MRF573 COMMON EMITTER S-PARAMETERS

| Var | lc | -, | 8- | 11 | S | 21 | S ₁ | 2 | S ₂₂ | |
|----------------------------|------------|-------|-----------------|-----------|-----------------|-----------|-----------------|------------|-----------------|--------------|
| V _{CE} (Volts) | (mA) | (MHz) | S ₁₁ | ∠φ | S ₂₁ | Δφ | S ₁₂ | Δ φ | S ₂₂ | Δφ |
| 6.0 | 5.0 | 200 | 0.76 | -73 | 10.6 | 134 | 0.06 | 52 | 0.72 | -40 |
|] | " | 500 | 0.61 | - 132 | 6.0 | 100 | 0.09 | 35 | 0.41 | -63 |
| | | 1000 | 0.59 | - 173 | 3.2 | 77 | 0.11 | 33 | 0.24 | -76 |
| l 1 | 1 | 1500 | 0.61 | 165 | 2.2 | 59 | 0.12 | 35 | .0.19 | -99 |
| | | 2000 | 0.64 | 149 | 1.8 | 45 | 0.13 | 36 | 0.18 | -117 |
| | 10 | 200 | 0.64 | -99 | 15.1 | 122 | 0.05 | 48 | 0.56 | - 55 |
| } | 1 | 500 | 0.58 | - 152 | 7.2 | 94 | 0.07 | 41 | 0.27 | -81 |
| | 1 1 | 1000 | 0.58 | 175 | 3.8 | 74 | 0.09 | 45 | 0.14 | - 102 |
| \ | l i | 1500 | 0.60 | 158 | 2.6 | 60 | 0.12 | 47 | 0.13 | - 135 |
| | | 2000 | 0.64 | 144 | 2.0 | 46 | 0.13 | 45 | 0.13 | - 155 |
| | 50 | 200 | 0.54 | - 153 | 19.6 | 104 | 0.03 | 55 | 0.29 | -83 |
| | [[| 500 | 0.56 | - 179 | 8.1 | 85 | 0.05 | 62 | 0.13 | - 115 |
| Į. | 1 | 1000 | 0.59 | 162 | 4.1 | 71 | 0.09 | 63 | 0.08 | – 157 |
| | | 1500 | 0.61 | 150 | 2.8 | 58 | 0.12 | 60 | 0.12 | 179 |
| | | 2000 | 0.65 | 138 | 2.1 | 46 | 0.13 | 54 | 0.14 | 165 |
| 8.0 | 5.0 | 200 | 0.78 | -67 | 10.6 | 136 | 0.06 | 54 | 0.75 | -36 |
| | | 500 | 0.61 | - 125 | 6.1 | 102 | 0.09 | 36 | 0.44 | -56 |
| 1 | | 1000 | 0.57 | - 169 | 3.4 | 78 | 0.10 | 33 | 0.27 | -66 |
| 1 | 1 | 1500 | 0.59 | 168 | 2.3 | 60 | 0.12 | 35 | 0.21 | -84 |
| J | 1 | 2000 | 0.62 | 161 | 1.8 | 46 | 0.14 | 36 | 0.19 | - 100 |
| | 10 | 200 | 0.66 | -92 | 15.3 | 125 | 0.05 | 49 | 0.60 | -49 |
| Į. | | 500 | 0.55 | - 147 | 7.5 | 95 | 0.07 | 41 | 0.30 | -70 |
| 1 | | 1000 | 0.55 | 178 | 3.9 | 76 | 0.09 | 45 | 0.16 | -81 |
| \ | 1 | 1500 | 0.67 | 160 | 2.7 | 60 | 0.12 | 47 | 0.12 | - 109 |
| 1 | <i>l</i> . | 2000 | 0.62 | 146 | 2.1 | 47 | 0.13 | 45 | 0.11 | - 130 |
| 1 | 50 | 200 | 0.53 | - 147 | 20.8 | 105 | 0.02 | 47 | 0.31 | -73 |
| l | | 500 | 0.63 | - 176 | 9.0 | 87 | 0.04 | 67 | 0.16 | -90 |
| ł | i l | 1000 | 0.57 | 166 | 4.6 | 72 | 0.07 | 61 | 0.08 | -110 |
| 1 | 1 | 1500 | 0.59 | 161 | 3.1 | 61 | 0.11 | 59 | 0.07 | - 154 |
| 1 | | 2000 | 0.63 | 143 | 2.3 | 49 | 0.13 | 55 | 0.09 | - 172 |

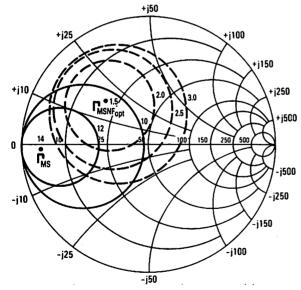
MRF571 — CONSTANT GAIN and NOISE FIGURE CONTOURS



| | | 6.0 V, I | 3 = 5 | .0 mA | |
|---|------|----------|-------|--------|------|
| f | = 50 | 0 MHz | | | |
| 8 | 23 — | REGION | OF IN | ISTABI | LITY |

| f(GHz) | NFOPT(dB) | Rn (Ω) | NF50 Ω (dB) |
|--------|-----------|--------|-------------|
| 0.5 | 0.9 | 9.3 | 1.3 |

| CmsNFOPT | K |
|-----------------|------|
| 0.49 ∠74° | 0.58 |

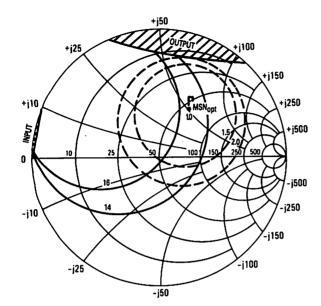


$$V_{CE} = 6.0 \text{ V, I}_{C} = 5.0 \text{ mA}$$
 f = 1.0 GHz

| f(GHz) | NF _{OPT} (dB) | Rn (Ω) | NF50 Ω (dB) | CmsNFOPT |
|--------|------------------------|--------|-------------|-----------------|
| 1.0 | 1.5 | 7.5 | 2.2 | 0.48 ∠134° |

| Гms | ΓmL |
|---------------|-----------|
| 0.89 ∠ - 179° | 0.81 ∠66° |

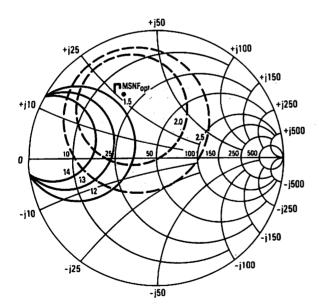
MRF572, MRF573 — CONSTANT GAIN and NOISE FIGURE CONTOURS



V_{CE} = 6.0 V, I = 5.0 mA f = 500 MHz M — REGION OF INSTABILITY

| f(GHz) | Rn (Ω) | NE (500) | EmsNFORT |
|--------|-----------|------------|-----------------|
| I(GHZ) | (11) (22) | 141 (5022) | 11113111 UFT |
| 0.5 | 17.1 | 1.5 | 0.43 ∠ 57° |

| K | NFOPT |
|------|-------|
| 0.55 | 1.0 |

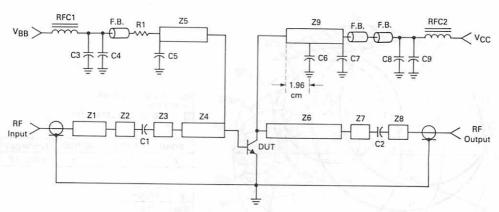


 $V_{CE} = 6.0 \text{ V, I}_{C} = 5.0 \text{ mA}$ f = 1.0 GHz

| f(GHz) | NFOPT | Rn (Ω) | NF50 (Ω) (dB) |
|--------|-------|--------|---------------|
| 1.0 | 1.5 | 6.0 | 2.0 |

| ΓmsNF | ОРТ | K |
|--------|------|------|
| 0.56 ∠ | 116° | 0.93 |

MRF571 1.0 GHz TEST CIRCUIT



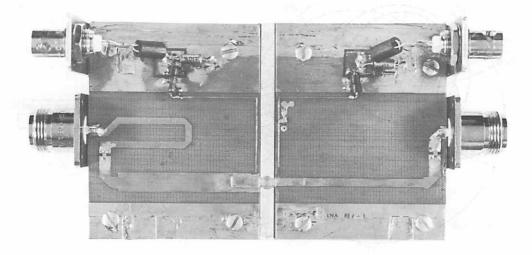
C1, C2, C6 C5, C7 C3, C8 C4, C9

R1

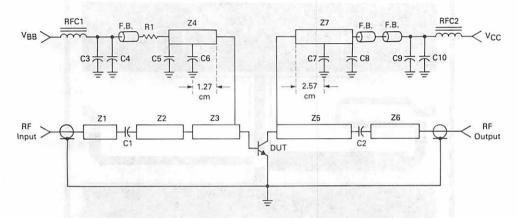
560 pF Chip Capacitor 0.018 μ F Chip Capacitor 0.1 μ F Mylar Capacitor 1.0 μ F Electrolytic Capacitor 2.7 $k\Omega$

RFC1, RFC2 Z1-Z9 Bead Board Material VK-200, Ferroxcube Microstrip, See Photomaster Ferrite Bead, Ferroxcube 56-590-65/3B 0.0625" Teflon Fiberglass $\epsilon_r=2.5\,\pm\,0.05$

MRF571 TEST CIRCUIT



MRF572, 573 1.0 GHz TEST FIXTURE



C1, C2, C6, C7 C5, C8

C3, C9 C4, C10 R1 560 pF Chip Capacitor 0.018 μF Chip Capacitor 0.1 μF Mylar Capacitor

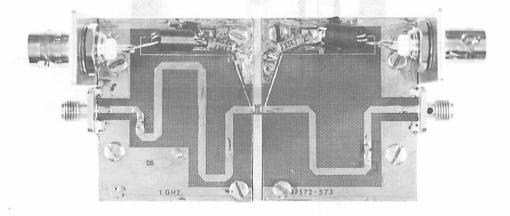
1.0 μ F Electrolytic Capacitor 2.7 $k\Omega$

RFC1, RFC2 Z1-Z7

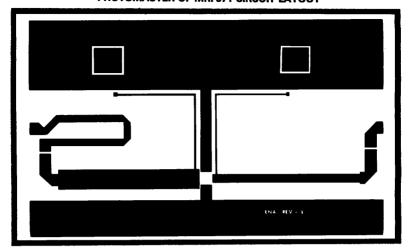
Bead Board Material VK-200, Ferroxcube

Microstrip, See Photomaster Ferrite Bead, Ferroxcube 56-590-65/3B 0.031" Teflon Fiberglass $\epsilon_{\rm f}=2.5\,\pm\,0.05$

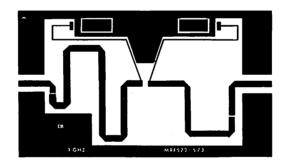
MRF572, 573 TEST CIRCUIT



PHOTOMASTER OF MRF571 CIRCUIT LAYOUT



PHOTOMASTER OF MRF572, 573 CIRCUIT LAYOUT



CASE 317A-01, STYLE 2
HIGH FREQUENCY TRANSISTOR
NPN SILICON

MRF581

CASE 317-01, STYLE 2
HIGH FREQUENCY TRANSISTOR
NPN SILICON

MAXIMUM RATINGS

| MAXIMOM NATINGS | | | | |
|--|-----------------------------------|------------------|----------------|----------------|
| Rating | Symbol | MRF581 | MRF581 | Unit |
| Collector-Emitter Voltage | VCEO | 18 | 18 | Vdc |
| Collector-Base Voltage | VCBO | 36 | 36 | Vdc |
| Emitter-Base Voltage | VEBO | 2.5 | 2.5 | Vdc |
| Collector Current — Continuous | lc | 200 | 200 | mAdc |
| Total Device Dissipation @ T _C = 50°C(1) Derate above T _C = 50°C | PD | 2.5 25 | 2.5 25 | Watts mW/°C |
| Operating and Storage Junction Temperature Range | T _J , T _{stg} | - 65 to + 150 | -65 to +150 | ℃ |

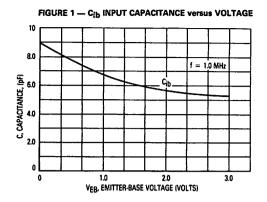
⁽¹⁾ Case temperature measured on collector lead immediately adjacent to body of package.

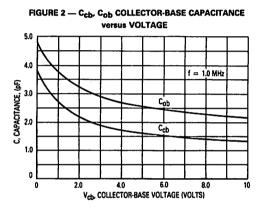
| ELECTRICAL CHARACTERISTICS (TA = 25°C unless o | therwise noted.) | | | | | |
|---|------------------|------------------|-----|------|----------|------|
| Characteristic | | Symbol | Min | Тур | Max | Unit |
| OFF CHARACTERISTICS | | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, IB = 0) | | V(BR)CEO | 18 | - | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 1.0 mAdc, IE = 0) | | V(BR)CBO | 36 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 0.10 mAdc, IC = 0) | | V(BR)EBO | 2.5 | _ | 1 | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) | | ICBO | _ | _ | 100 | μAdc |
| Emitter Cutoff Current (VCE = 2.0 Vdc, VBE = 0) | | [†] EBO | _ | - | 100 | μAdc |
| ON CHARACTERISTICS | | | | | | |
| DC Current Gain(1) (IC = 50 mAdc, VCE = 5.0 Vdc) | | hFE | 50 | _ | 200 | _ |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Current-Gain — Bandwidth Product (IC = 75 mAdc, VCE = 10 Vdc, f = 1.0 GHz) | | fτ | - | 5.0 | - | GHz |
| Collector-Base Capacitance {VCB = 10 Vdc, IE = 0, f = 1.0 MHz} | | C _{cb} | 1 | 1.4 | 2.0 | pF |
| FUNCTIONAL TESTS | | | | | | |
| Noise Figure MRF580/581 (IC = 50 mAdc, VCE = 10 Vdc, f = 0.5 GHz) | Figure 18 | NF | 1 | 2.0 | 3.0 | dΒ |
| Power Gain at Optimum Noise Figure MRF580 (IC = 50 mAdc, VCE = 10 Vdc, f = 0.5 GHz) | Figure 18 | GNF | 11 | 14 | _ | dB |
| Power Gain at Optimum Noise Figure MRF581 (IC = 50 mAdc, VCE = 10 Vdc, f = 0.5 GHz) | Figure 18 | GNF | 13 | 15.5 | _ | dB |
| Maximum Available Power Gain MRF580(2) (IC = 75 mAdc, VCE = 10 Vdc, f = 0.5 GHz) | | G _{max} | _ | 15 | _ | dB |
| Maximum Available Power Gain MRF581(2) (IC = 75 mAdc, VCE = 10 Vdc, f = 0.5 GHz) | | G _{max} | 1 | 17.5 | _ | dB |
| Intermodulation Distortion MRF581(3) (VCE = 10 V, IC = 75 mA, V _{Out} = +50 dBmV) | Figure 16 | IMD(d3) | _ | -65 | | ₫B |

^{(1) 300} μs pulse on Tektronix 576 or equivalent.

⁽²⁾ Characterized on HP8542 Automatic Network Analyzer.

^{(3) 2} Tones, f1 = 497 MHz, f2 = 503 MHz, 3rd Order Single Tone reference.





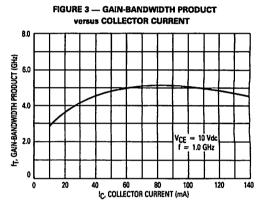
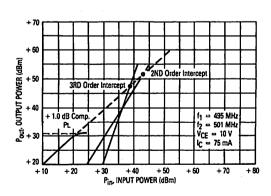


FIGURE 4 — 2ND AND 3RD ORDER INTERCEPT POINTS



MRF580 TYPICAL PERFORMANCE

FIGURE 5 — GU max-MAXIMUM UNILATERAL GAIN, |S₂₁|² versus FREQUENCY

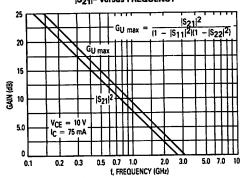


FIGURE 6 — GA max, MAXIMUM AVAILABLE GAIN versus FREQUENCY

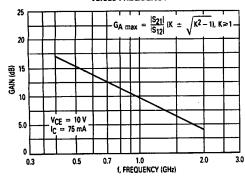


FIGURE 7 — NOISE FIGURE AND GAIN ASSOCIATED

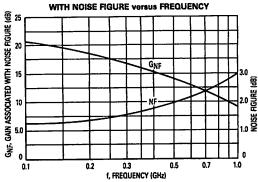


FIGURE 8 — NOISE FIGURE AND GAIN ASSOCIATED WITH

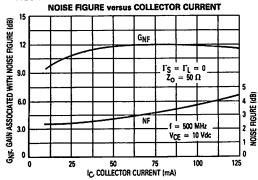
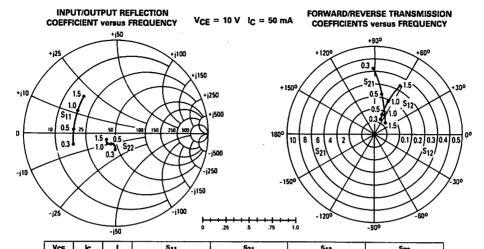


FIGURE 9 -- MRF580 COMMON EMITTER S-PARAMETERS



| VCE | lc (mA) | f (MHz) | S ₁₁ | | S ₂₁ | | S ₁₂ | | S ₂₂ | |
|---------|------------|------------|-----------------|-------|-----------------|------|-----------------|----|--------------------|----------|
| (Volts) | | | S ₁₁ | ۷. | S ₂₁ | ۷. | S ₁₂ | 4 | [S ₂₂] | ۷ |
| 5.0 | | 300 | 0.49 | - 170 | 5.97 | 91 | 0.083 | 60 | 0.24 | - 108 |
| | 25 | 500 | 0.52 | 171 | 3.63 | 78 | 0.127 | 64 | 0.18 | - 117 |
| | | 1000 | 0.53 | 149 | 1.98 | 58 | 0.24 | 66 | 0.13 | - 154 |
| | | 1500 | 0.56 | 125 | .1.46 | 44 | 0.35 | 60 | 0.19 | - 172 |
| | | 300 | 0.48 | - 175 | 6.35 | 90 | 0.08 | 64 | 0.24 | - 126 |
| | 50 | 500 | 0.51 | 168 | 3.85 | 79 | 0.13 | 67 | 0.18 | - 139 |
| | | 1000 | 0.51 | 148 | 2.10 | 59 | 0.25 | 66 | 0.16 | - 178 |
| | | 1500 | 0.54 | 123 | 1.56 | 46 | 0.36 | 58 | 0.20 | 169 |
| | | 300 | 0.48 | - 177 | 6.42 | 90 | 0.08 | 65 | 0.24 | - 132 |
| | 75 | 500 | 0.51 | 167 | 3.88 | 79 | 0.13 | 67 | 0.19 | - 145 |
| | | 1000 | 0.50 | 147 | 2.12 | 59 | 0.26 | 65 | 0.17 | 175 |
| | | 1500 | 0.53 | 123 | 1.57 | 46 | 0.36 | 58 | 0.21 | 164 |
| | 100 | 300 | 0.48 | - 177 | 6.41 | 89 | 0.08 | 66 | 0.24 | - 134 |
| | | 500 | 0.51 | 167 | 3.87 | 78 | 0.13 | 68 | 0.19 | - 148 |
| | | 1000 | 0.51 | 146 | 2.114 | 59 | 0.26 | 65 | 0.17 | 172 |
| | | 1500 | 0.53 | 123 | 1.58 | 46 | 0.36 | 58 | 0.21 | 162 |
| 10 | 25 | 300 | 0.44 | - 164 | 6.67 | 92 | 0.07 | 61 | 0.25 | - 76 |
| | | 500 | 0.47 | 175 | 4.08 | 79 | 0.11 | 66 | 0.19 | - 75 |
| | | 1000 | 0.48 | 152 | 2.2 | 60 | 0.21 | 68 | 0.12 | - 91 |
| | | 1500 | 0.52 | 126 | 1.56 | 45 | 0.32 | 64 | 0.15 | - 129 |
| | 50 | 300 | 0.47 | - 167 | 7.40 | 91 | 0.07 | 65 | 0.17 | - 89 |
| | | 500 | 0.47 | 174 | 4.53 | 79 | 0.11 | 68 | 0.12 | - 112 |
| | | 1000 | 0.50 | 149 | 2.38 | 62 | 0.20 | 67 | 0.13 | - 126 |
| | | 1500 | 0.53 | 131 | 1.71 | 47 | 0.31 | 63 | 0.11 | - 147 |
| | 75 | 300 | 0.41 | - 171 | 7.24 | 91 | 0.07 | 66 | 0.20 | - 96 |
| | | 500 | 0.45 | 171 | 4.39 | 79 | 0.12 | 69 | 0.13 | -99 |
| | '• | 1000 | 0.45 | 150 | 2.36 | 61 | 0.23 | 67 | 0.07 | - 130 |
| | <u> </u> | 1500 | 0.48 | 125 | 1.72 | 47 | 0.33 | 61 | 0.12 | - 157 |
| | | 300 | 0.42 | - 172 | 7.22 | 90 | 0.07 | 67 | 0.19 | - 97 |
| | 100 | 500 | 0.45 | 170 | 4.38 | 78 | 0.12 | 69 | 0.14 | - 98 |
| | | 1000 | 0.45 | 149 | 2.35 | 60 | 0.23 | 67 | 0.07 | - 129 |
| | | 1500 | 0.49 | 125 | 1.71 | 46 | 0.33 | 62 | 0.11 | - 158 |
| 15 | 25 | 300 | 0.48 | - 159 | 7.28 | 93 | 0.06 | 60 | 0.24 | -55 |
| | | 500 | 0.48 | - 179 | 4.44 | 80 | 0.09 | 66 | 0.17 | -62 |
| | | 1000 | 0.51 | 153 | 2.33 | 62 | 0.18 | 68 | 0.19 | - 82 |
| | | 1500 | 0.54 | 133 | 1.67 | 45 | 0.27 | 68 | 0.17 | - 97 |
| | | 300 | 0.39 | - 165 | 7.49 | 0.92 | 0.07 | 65 | 0.23 | -71 |
| | 50 | 500 | 0.42 | 174 | 4.57 | 80 | 0.11 | 69 | 0.18 | -67 |
| | | 1000 | 0.43 | 152 | 2.44 | 61 | 0.21 | 68 | 0.11 | -74 |
| | | 1500 | 0.46 | 126 | 1.76 | 47 | 0.31 | 64 | 0.12 | - 115 |
| | | 300 | 0.39 | - 167 | 7.57 | 91 | 0.07 | 66 | 0.21 | - 74 |
| | 75 | 500 | 0.42 | 173 | 4.57 | 79 | 0.11 | 70 | 0.17 | - 69 |
| | | 1000 | 0.42 | 151 | 2.45 | 61 | 0.21 | 68 | 0.09 | -75 |
| | ļ | 1500 | 0.46 | 126 | 1.76 | 48 | 0.31 | 64 | 0.11 | - 118 |
| | | 300 | 0.39 | - 168 | 7.46 | 90 | 0.07 | 67 | 0.20 | -72 |
| | 100 | 500 | 0.43 | 172 | 4.53 | 78 | 0.11 | 70 | 0.17 | - 66 |
| | | 1000 | 0.43 | 151 | 2.41 | 60 | 0.21 | 69 | 0.10 | -71 |
| | | 1500 | 0.47 | 126 | 1,74 | 46 | 0.31 | 64 | 0.12 | 113 |

MRF581 TYPICAL PERFORMANCE

FIGURE 10 — GU $_{
m max}$ — MAXIMUM UNILATERAL GAIN, |S₂₁|² versus FREQUENCY 25 $\frac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$ 20 15 GAIN (dB) VCE = 10 V IC = 75 mA 5.0 1.0 5.0 7.0 0.3 0.5 0.7 2.0 0.1 0.2 f, FREQUENCY (GHz)

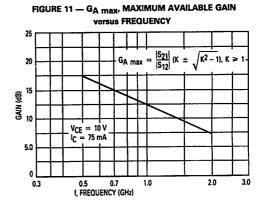
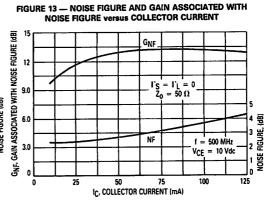
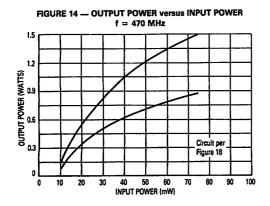


FIGURE 12 — NOISE FIGURE AND GAIN ASSOCIATED
WITH NOISE FIGURE versus FREQUENCY

(9)
20
GNF
15
NF
VCC = 10V
1c = 50 mA
1, FREQUENCY (GHz)





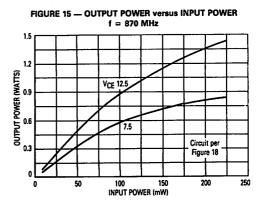
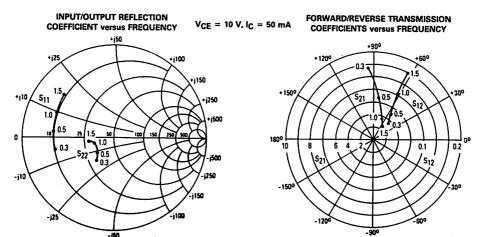
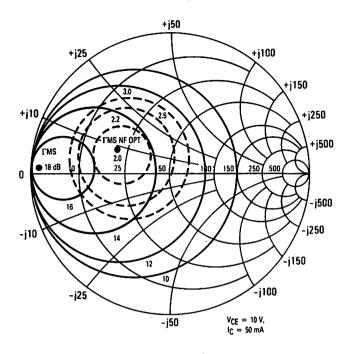


FIGURE 16 — MRF581 COMMON EMITTER S-PARAMETERS



| VCE | , lc | | \$ | 11 | S | 21 | S | 12 | \$22 | |
|---------|------|-------|-----------------|-------|-----------------|-----|-----------------|----|-----------------|-------|
| (Volts) | (mA) | (MHz) | S ₁₁ | ۷. | S ₂₁ | 4 | S ₁₂ | ۷. | S ₂₂ | 4 |
| 5.0 | | 300 | 0.69 | - 169 | 6.57 | 93 | 0.06 | 39 | 0.34 | - 129 |
| | 25 | 500 | 0.72 | 176 | 3.95 | 82 | 0.07 | 47 | 0.29 | - 142 |
| | 25 | 1000 | 0.73 | 157 | 2.10 | 62 | 0.12 | 60 | 0.27 | - 165 |
| | | 1500 | 0.76 | 139 | 1.47. | 50 | 0.17 | 61 | 0.33 | - 172 |
| | | 300 | 0.70 | - 173 | 2.14 | 93 | 0.05 | 45 | 0.38 | - 144 |
| | 50 | 500 | 0.72 | 173 | 4.27 | .82 | 0.07 | 53 | 0.34 | - 157 |
| | " | 1000 | 0.72 | 157 | 2.24 | 65 | 0.13 | 62 | 0.33 | 179 |
| | | 1500 | 0.76 | 138 | 1.61 | 53 | 0.18 | 61 | 0.37 | 173 |
| | | 300 | 0.70 | - 175 | 7.26 | 92 | 0.05 | 48 | 0.40 | - 148 |
| | 75 | 500 | 0.72 | 172 | 4.33 | 82 | 0.07 | 55 | 0.36 | - 161 |
| | ,,, | 1000 | 0.72 | 155 | 2.28 | 65 | 0.13 | 63 | 0.35 | 176 |
| | | 1500 | 0.76 | 138 | 1.64 | 53 | 0.19 | 61 | 0.39 | 170 |
| | | 300 | 0.70 | - 176 | 7.30 | 92 | 0.05 | 48 | 0.40 | - 151 |
| | 100 | 500 | 0.72 | 172 | 4.34 | 82 | 0.07 | 56 | 0.37 | - 163 |
| | 100 | 1000 | 0.72 | 155 | 2.28 | 65 | 0.13 | 63 | 0.362 | 175 |
| | | 1500 | 0.75 | 137 | 1.64 | 53 | 0.19 | 61 | 0.39 | 168 |
| 10 | | 300 | 0.66 | - 165 | 7.58 | 95 | 0.05 | 40 | 0.29 | - 106 |
| | 25 | 500 | 0.69 | 178 | 4.56 | 82 | 0.07 | 48 | 0.23 | - 116 |
| | 25 | 1000 | 0.70 | 159 | 2.39 | 64 | 0.11 | 61 | 0.19 | - 141 |
| | | 1500 | 0.74 | 141 | 1.65 | 50 | 0.16 | 64 | 0.26 | - 153 |
| | | 300 | 0.65 | - 169 | € 8.25 | 94 | 0.05 | 46 | 0.30 | - 126 |
| | 50 | 500 | 0.68 | 175 | 4.96 | 82 | 0.07 | 54 | 0.24 | - 138 |
| | 30 | 1000 | 0.69 | 157 | 2.60 | 65 | 0.12 | 63 | 0.22 | - 164 |
| | | 1500 | 0.72 | 139 | 1.82 | 52 | 0.17 | 63 | 0.27 | - 171 |
| | | 300 | 0.66 | - 171 | 8.49 | 93 | 0.05 | 48 | 0.30 | - 132 |
| | 75 | 500 | 0.68 | 175 | 5.06 | 82 | 0.07 | 55 | 0.25 | - 145 |
| | /5 | 1000 | 0.69 | 157 | 2.64 | 65 | 0.12 | 64 | 0.23 | - 170 |
| | | 1500 | 0.72 | 139 | 1.86 | 53 | 0.17 | 63 | 0.27 | 176 |
| | | 300 | 0.66 | ~ 172 | 8.46 | 93 | 0.05 | 49 | 0.30 | - 134 |
| | 100 | 500 | 0.68 | 174 | 5.06 | 82 | 0.07 | 56 | 0.25 | - 147 |
| | | 1000 | 0.68 | 157 | 2.64 | 65 | 0.12 | 64 | 0.23 | - 172 |
| | | 1500 | 0.72 | 139 | 1.86 | 52 | 0.17 | 63 | 0.27 | - 177 |
| 15 | | 300 | 0.65 | - 163 | 7.96 | 95 | 0.05 | 40 | 0.28 | - 92 |
| | 25 | 500 | 0.67 | 179 | 4.82 | 82 | 0.06 | 48 | 0.21 | - 98 |
| | | 1000 | 0.68 | 160 | 2.51 | 63 | 0.10 | 62 | 0.17 | - 119 |
| | | 1500 | 0.72 | 141 | 1.73 | 49 | 0.16 | 65 | 0.24 | - 137 |
| | | 300 | 0.64 | - 167 | 8.76 | 94 | 0.0 | 46 | 0.26 | - 112 |
| | 50 | 500 | 0.66 | 177 | 5.37 | 82 | 0.06 | 54 | 0.20 | - 122 |
| | | 1000 | 0.67 | 159 | 2.75 | 65 | 0.11 | 64 | 0.16 | - 148 |
| | | 1500 | 0.71 | 141 | 1.91 | 51 | 0.16 | 64 | 0.22 | - 157 |
| | | 300 | 0.64 | - 168 | 8.93 | 93 | 0.05 | 47 | 0.25 | - 117 |
| | 75 | 500 | 0.66 | 176 | 5.34 | 82 | 0.06 | 55 | 0.20 | - 128 |
| | . • | 1000 | 0.69 | 158 | 2.78 | 65 | 0.11 | 65 | 0.16 | - 154 |
| | | 1500 | 0.70 | 140 | 1.93 | 51 | 0.16 | 64 | 0.22 | - 162 |
| | | 300 | 0.64 | - 169 | 8.91 | 93 | 0.05 | 48 | 0.25 | - 117 |
| i | 100 | 500 | 0.66 | 176 | 5.33 | 82 | 0.6 | 56 | 0.19 | - 129 |
| | | 1000 | 0.67 | 158 | 2.78 | 64 | 0.11 | 65 | 0.16 | - 154 |
| | | 1500 | 0.70 | 140 | 1.93 | 51 | 0.16 | 64 | 0.21 | - 160 |

FIGURE 17 -- MRF581 CONSTANT GAIN CONTOURS NOISE FIGURE CONTOURS



| f(MHz) | гмѕ | ΓML | I'MS NF OPT | G _A MAX (dB) | | | |
|--------|--------------------|----------|--------------------|----------------------------|------|-----|-----|
| 500 | 0.91 <u>/176</u> ° | 0.78/77° | 0.39 <u>/159</u> ° | 18 | 10.5 | 2.0 | 2.5 |

Circuit Per Figure 20

FIGURE 18 — FUNCTIONAL CIRCUIT SCHEMATIC

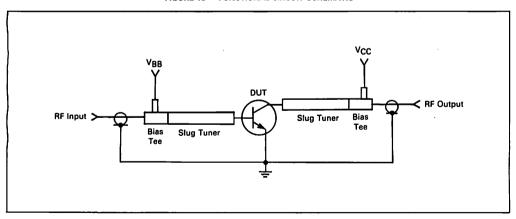


FIGURE 19 — Zin AND ZOL Versus COLLECTOR VOLTAGE, INPUT POWER AND FREQUENCY

| Pta | f | | in ms | Z _{OL} * Ohms | | |
|-------------|-----|--------------|--------------|---------------------------|--------------|--|
| Pin (mW) | MHz | 7.5 V | 12.5 V | 7.5 V | 12.5 V | |
| | 420 | 9.8 - j12.0 | 10.3 - j11.1 | 27.5 - j2.7 | 54.5 + j5.7 | |
| 50 | 470 | 14.2 - j11.1 | 10.2 - j10.2 | 28.6 - j2.9 | 30.8 - j26.3 | |
| | 520 | 13.6 - j8.6 | 8.2 - j7.7 | 27.0 - j5.0 | 30.4 - j26.0 | |
| | 806 | 7.6 + j1.3 | 7.7 + j0.8 | 16.4 - j22.7 | 22.3 - j34.0 | |
| 75 | 870 | 7.7 - j1.7 | 7.7 - j2.1 | 18.4 - j19.2 | 25.1 - j28.1 | |
| Ī | 960 | 6.0 + j4.3 | 5.9 + j2.5 | 21 - j17.1 | 24.5 - j20.4 | |

^{*}ZOL = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 20 — MRF880/581 TEST FIXTURE SCHEMATIC 500 MHz

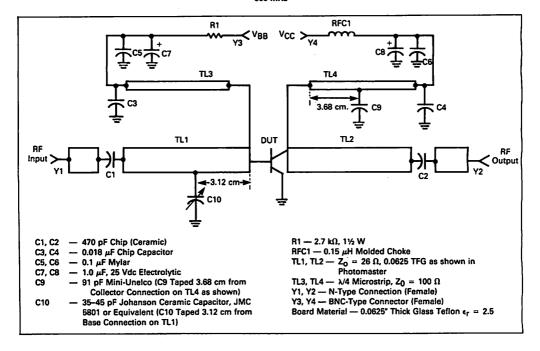
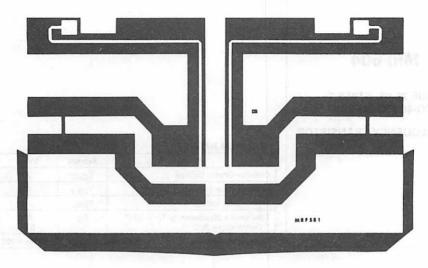
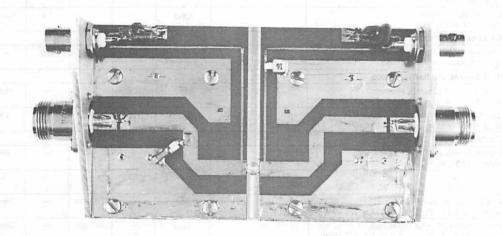


FIGURE 21 — PC BOARD PHOTOMASTER





CASE 26-03, STYLE 1 TO-46 (TO-206AB)

HIGH FREQUENCY TRANSISTOR

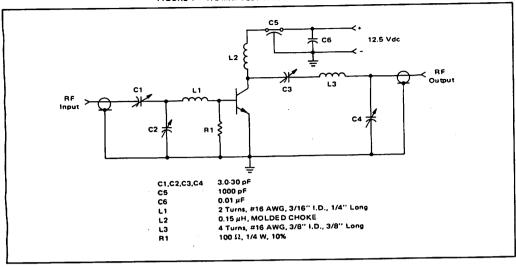
NPN SILICON

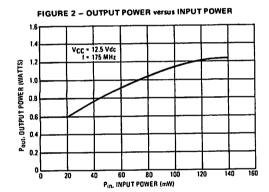
MAXIMUM RATINGS

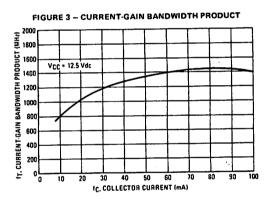
| MAXIMOM RATINGS | | | |
|---|--------|-------------|---------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Base Voltage | VCBO | 40 | Vdc |
| Emitter-Base Voltage | VEBO | 2.0 | Vdc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.5 0.04 | Watts W/°C |
| Storage Temperature | Tstg | -65 to +200 | °C |

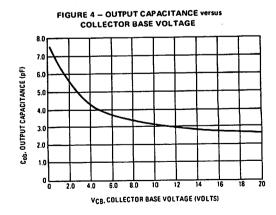
| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|------------------|-----|----------|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 5.0 mAdc, Ig = 0) | V(BR)CEO | 20 | _ | | Vdc |
| Collector-Base Breakdown Voltage (IC = 100 µAdc, IE = 0) | V(BR)CBO | 40 | - | - | Vdc |
| Emitter-Base Breakdown Voltage (IE = 100 µAdc, IC = 0) | V(BR)EBO | 3.5 | - | _ | Vdc |
| Collector Cutoff Current (VCE = 12 Vdc, IB = 0) | ICEO | ı | | 1.0 | mAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 50 mAdc, VCE = 5.0 Vdc) | hFE | 20 | 80 | 200 | _ |
| SMALL SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, VCE = 10 Vdc, f = 200 MHz) | fŢ | 800 | - | _ | MHz |
| Output Capacitance (VCB = 12.5 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | - | _ | 3.5 | pF |
| FUNCTIONAL TEST (FIGURE 1) | | | | | |
| Common-Emitter Amplifier Power Gain (VCC = 12.5 Vdc, P _{out} = 1.0 W, f = 175 MHz) | GPE | 10 | - | - | dB |
| Collector Efficiency (VCC = 12.5 Vdc, Pout = 1.0 W, f = 175 MHz) | η | 50 | - | - | % |
| Series Equivalent Input Impedance (VCC = 12.5 Vdc, Pout = 1.0 W, f = 175 MHz) | Z _{in} | _ | 7.5-j14 | _ | Ohms |
| Series Equivalent Output Impedance (VCC = 12.5 Vdc, P _{out} = 1.0 W, f = 175 MHz) | Z _{out} | _ | 47 – j60 | _ | Ohms |

FIGURE 1 - 175 MHz TEST CIRCUIT SCHEMATIC









CASE 79-02, STYLE 1 TO-39 (TO-205AD)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

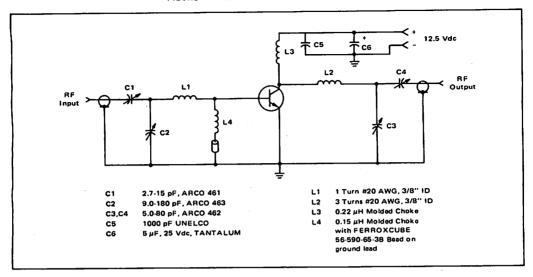
MAXIMUM RATINGS

| Rating | Symbol | Value | Unit | |
|--|------------------|-------------|----------------|--|
| Collector-Emitter Voltage | VCEO | 16 | Vdc | |
| Collector-Base Voltage | V _{CBO} | 36 | Vdc | |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc | |
| Collector Current — Continuous | lc | 0.33 | Adc | |
| Total Device Dissipation @ T _C = 75°C(1) Derate above 75°C | PD | 3.5 28 | Watts mW/°C | |
| Storage Temperature | T _{stq} | -65 to +200 | °C | |

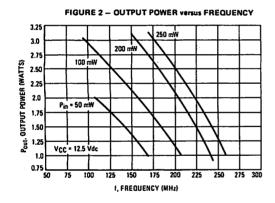
⁽¹⁾ These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as class B or C RF amplifiers.

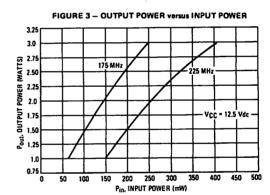
| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|------|-----|----------|
| OFF CHARACTERISTICS | | | | 1 |
| Collector-Emitter Breakdown Voltage (IC = 25 mAdc, Ig = 0) | V(BR)CEO | 16 | _ | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 25 mAdc, V _{BE} = 0) | V(BR)CES | 36 | - | Vdc |
| Emitter-Base Breakdown Voltage (Ig = 0.5 mAdc, IC = 0) | V(BR)EBO | 4.0 | | Vdc |
| Collector Cutoff Current (VCE = 10 Vdc, Ig = 0) | ICEO | - | 0.3 | mAdc |
| ON CHARACTERISTICS | | _ | | <u> </u> |
| DC Current Gain (IC = 50 mAdc, VCE = 5.0 Vdc) | hFE | 20 | 150 | _ |
| SMALL SIGNAL CHARACTERISTICS | | | | <u> </u> |
| Output Capacitance (V _{CB} = 12 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | | 15 | pF |
| FUNCTIONAL TEST (FIGURE 1) | | | | |
| Common-Emitter Amplifier Power Gain (Pout = 1.75 W, V _{CC} = 12.5 Vdc, f = 175 MHz) | GPE | 11.5 | _ | dB |
| Collector Efficiency (Pout = 1.75 W, VCC = 12.5 Vdc, f = 175 MHz) | η | 50 | - | % |

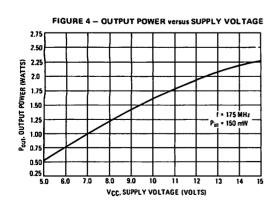
FIGURE 1 - 175 MHz TEST CIRCUIT SCHEMATIC

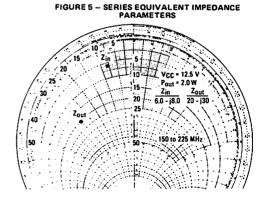


TYPICAL PERFORMANCE DATA









MRF626 MRF627

MRF626 CASE 305-01, STYLE 1

MRF627 CASE 305A-01, STYLE 1

HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|---------------|----------------|
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Base Voltage | VCBO | 30 | Vdc |
| Emitter-Base Voltage | VEBO | 3.5 | Vdc |
| Collector Current — Continuous | lc | 150 | mAdc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 2.5 35 | Watts mW/°C |
| Storage Temperature | T _{stg} | -65 to +200°C | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|--------------------------------------|------------------|------|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 28.5 | °C⁄W |

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|------------------|-----|-------------------|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 5.0 mAdc, IB = 0) | V(BR)CEO | 20 | - | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.1 mAdc, I _E = 0) | V(BR)CBO | 30 | - | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 0.1 mAdc, IC = 0) | V(BR)EBO | 3.5 | - | | Vdc |
| Collector Cutoff Current (VCE = 12 Vdc, IB = 0) | ICEO | _ | - | 1.0 | mAdc |
| Emitter Cutoff Current (VBE = 3.5 Vdc, IC = 0) | l _{EBO} | _ | - | 1.0 | mAdc |
| ON CHARACTERISTICS | | | | | 1 |
| DC Current Gain (IC = 50 mAdc, VCE = 10 Vdc) | hFE | 15 | - | 150 | - |
| SMALL-SIGNAL CHARACTERISTICS | | - | | | |
| Current-Gain — Bandwidth Product (IC = 50 mAdc, V _{CE} = 12.5 Vdc, f = 200 MHz) (IC = 100 mAdc, V _{CE} = 12.5 Vdc, f = 200 MHz) (IC = 150 mAdc, V _{CE} = 12.5 Vdc, f = 200 MHz) | ſτ | | 2.5 2.7 2.6 | = | GHz |
| Output Capacitance (VCB = 12.5 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | _ | 3.0 | 3.5 | pF |
| Input Capacitance (V _{BE} = 1.0 Vdc, I _C = 0, f = 1.0 MHz) | C _{ibo} | ı | 8.8 | _ | pF |
| FUNCTIONAL TEST (FIGURE 1) | | | | | • |
| Common-Emitter Amplifier Power Gain (VCC = 12.5 Vdc, P _{out} = 0.5 W, f = 470 MHz) | GPE | 10 | 12 | | dB |
| Collector Efficiency (VCC = 12.5 Vdc, P _{out} = 0.5 W, f = 470 MHz) | η | - | 60 | _ | % |
| Series Equivalent input impedance (VCC = 12.5 Vdc, P _{out} = 0.5 W, f = 470 MHz) | Z _{in} | _ | 6.0 – j4.0 | _ | Ohms |
| Series Equivalent Output Impedance (VCC = 12.5 Vdc, Pout = 0.5 W, f = 470 MHz) | Z _{out} | _ | 45 – j28 | _ | Ohms |

MRF626 • MRF627

FIGURE 1 - OUTPUT POWER versus INPUT POWER

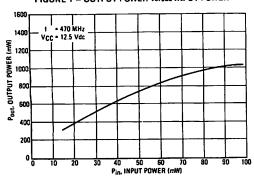


FIGURE 2 - OUTPUT CAPACITANCE versus **COLLECTOR BASE VOLTAGE**

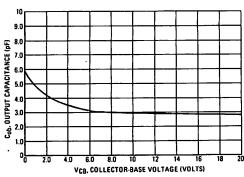
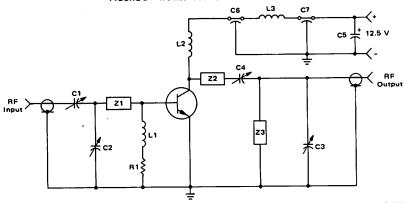


FIGURE 3 - 470 MHz TEST CIRCUIT SCHEMATIC



C1,C2 - 1.0-25 pF ARCO 421

C3,C4 - 1.0-25 pF ARCO 421

C5 - 1.0 μF, 35 V Capacitor C6,C7 - 1000 pF Feedthru

Choke FERROXCUBE VK 200-20-4B Z3 -L3 -R1 -

Z1 -

Z2 –

1 Ohm, 1/2 W Carbon Microstrip Line, 0.25" W x 1.75 " L Microstrip Line, 0.25" W x 2.00" L

Microstrip Line, 0.50" W x 1.00" L Board-Glass Teflon, 3" x 5" x 0.060" Mounting Plate is 3" x 5" x 0.75" Input/Output Connectors - Type N

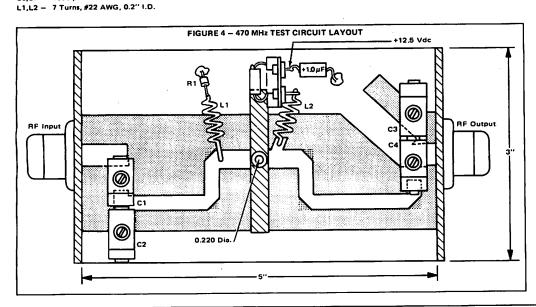
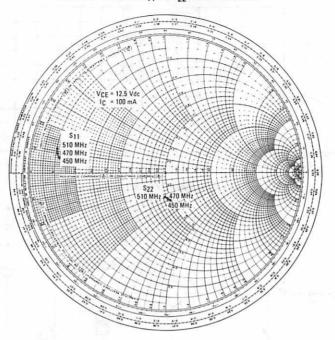


FIGURE 5 - TYPICAL S₁₁ and S₂₂ versus FREQUENCY





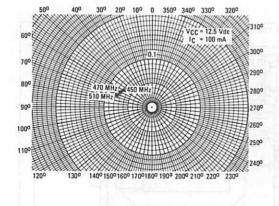
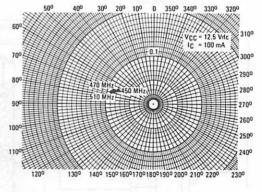


FIGURE 7 - TYPICAL S21 versus FREQUENCY



CASE 249-05, STYLE 1 UHF AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 16 | Vdc |
| Collector-Base Voltage | VCBO | 36 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | ΙC | 200 | mAdc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 3.0 17.2 | Watts mW/°C |
| Storage Temperature | T _{sto} | -65 to +200 | °C |

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|------------------|-----|-----|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage(1) (IC = 20 mAdc, Ig = 0) | V(BR)CEO | 16 | _ | _ | Vdc |
| Collector-Emitter Breakdown Voltage(1) (IC = 20 mAdc, VBE = 0) | V(BR)CES | 36 | _ | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 20 mAdc, Ig = 0) | V(BR)CBO | 36 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 5.0 mAdc, IC = 0) | V(BR)EBO | 4.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IC = 0) | ICBO | - | _ | 0.5 | mAdc |
| Collector Cutoff Current (VCE = 15 Vdc, VBE = 0, TC = 25°C) | CES | 1 | _ | 2.0 | mAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 100 mAdc, VCE = 5.0 Vdc) | hFE | 20 | _ | _ | _ |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Output Capacitance (VCB = 12 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | 1 | 6.0 | 10 | pF |
| FUNCTIONAL TEST (FIGURES 5 AND 6) | | | | | |
| Common-Emitter Amplifier Power Gain (VCC = 12.5 Vdc, Pout = 0.5 W, IC(max) = 80 mAdc, f = 470 MHz) | GPE | 10 | _ | _ | dB |
| Collector Efficiency (VCC = 12.5 Vdc, Pout = 0.5 W, IC(max) = 80 mAdc, f = 470 MHz) | η | 50 | _ | _ | % |

⁽¹⁾ Pulsed thru 25 mH inductor.

FIGURE 1 – SERIES EQUIVALENT IMPEDANCE PARAMETERS

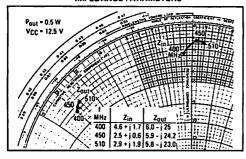


FIGURE 2 - OUTPUT POWER versus INPUT POWER

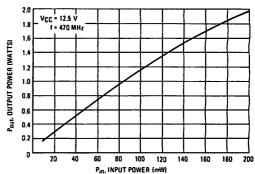


FIGURE 3 - OUTPUT POWER versus FREQUENCY

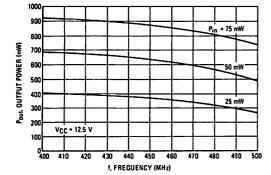


FIGURE 4 - OUTPUT POWER versus VOLTAGE

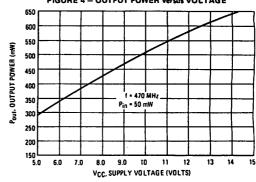


FIGURE 5 - 470 MHz TEST CIRCUIT

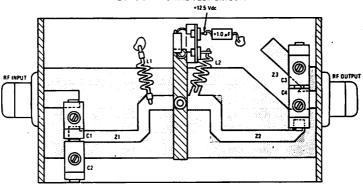
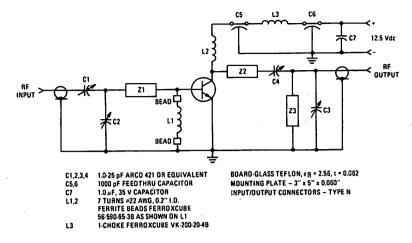


FIGURE 6 - 470 MHz TEST CIRCUIT SCHEMATIC



CASE 79-03, STYLE 5

HIGH FREQUENCY TRANSISTOR

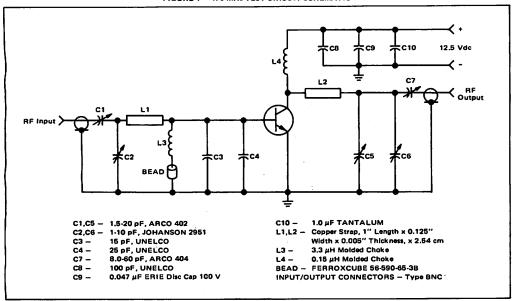
NPN SILICON

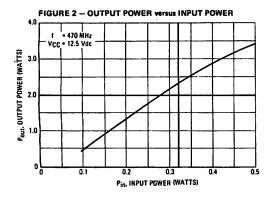
MAXIMUM RATINGS

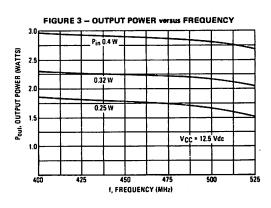
| Rating | Symbol | Value | Unit |
|---|------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 16 | Vdc |
| Collector-Base Voltage | VCBO | 36 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | lc | 400 | mAdc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 5.0 50 | Watts mW/°C |
| Storage Temperature | T _{sta} | -65 to +200 | ပံ့ |

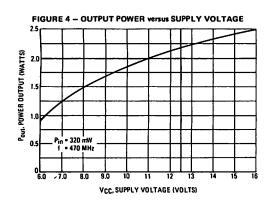
| Characteristic | Symbol | Min | Max | Unit |
|---|------------------|-----|-----|------|
| OFF CHARACTERISTICS | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 50 mAdc, I _B = 0) | V(BR)CEO | 16 | | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 50 mAdc, VBE = 0) | V(BR)CES | 36 | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 1.0 mAdc, I _C = 0) | V(BR)EBO | 4.0 | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 15 Vdc, I _E = 0) | ІСВО | | 1.0 | mAdc |
| ON CHARACTERISTICS | | | | |
| DC Current Gain (I _C = 100 mAdc, V _{CE} = 5.0 Vdc) | hFE | 20 | 200 | _ |
| SMALL-SIGNAL CHARACTERISTICS | | | | |
| Output Capacitance (V _{CB} = 12.5 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | _ | 15 | ρF |
| FUNCTIONAL TEST (FIGURE 1) | | | | |
| Common-Emitter Amplifier Power Gain (V _{CC} = 12.5 Vdc, P _{Out} = 2.0 W, f = 470 MHz) | GPE | 8.0 | _ | dB |
| Collector Efficiency (VCC = 12.5 Vdc, P _{Out} = 2.0 W, f = 470 MHz) | η | 50 | _ | % |

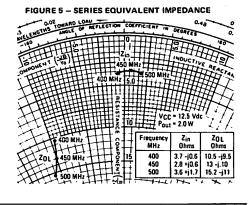
FIGURE 1 - 470 MHz TEST CIRCUIT SCHEMATIC











CASE 79-03, STYLE 5
UHF AMPLIFIER TRANSISTOR

NPN SILICON

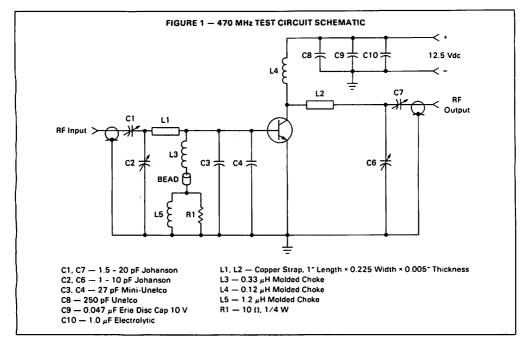
MAXIMUM RATINGS

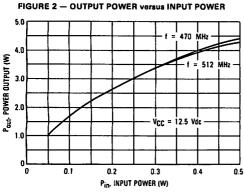
| Rating | Symbol | Value | Unit |
|---|------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 16 | Vdc |
| Collector-Base Voltage | VCES | 36 | Vdc |
| Emitter-Base Voltage | VEBO | 4.0 | Vdc |
| Collector Current — Continuous | lc | 1.0 | Adc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 8.75 50 | Watts mW/°C |
| Storage Temperature | T _{sto} | -65 to +200 | .დ |

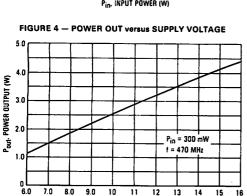
THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|--------------------------------------|------------------|-----|------|
| Thermal Resistance, Junction to Case | R _{ØJC} | 20 | °C/W |

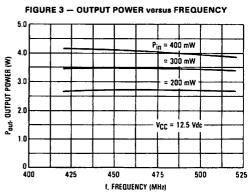
| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|----------|-----|-----|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 50 mAdc, IB = 0) | V(BR)CEO | 16 | _ | _ | Vdc |
| Collector-Emitter Breakdown Voltage (I _C = 50 mAdc, V _{BE} = 0) | V(BR)CES | 36 | - | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 1.0 mAdc, I _C = 0) | V(BR)EBO | 4.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCE = 12.5 Vdc, VBE = 0, TC = 25°C) | ICES | | - | 1.0 | mAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 100 mAdc, VCE = 5.0 Vdc) | hFE | 20 | 60 | _ | - |
| SMALL SIGNAL CHARACTERISTICS | | | | | |
| Output Capacitance (VCB = 12.5 Vdc, IE = 0, f = 1.0 MHz) | Cobo | _ | 8.0 | 12 | pF |
| FUNCTIONAL TEST (FIGURE 1) | | | | | |
| Common-Emitter Amplifier Power Gain (VCC = 12.5 Vdc, P _{out} = 3.0 W, f = 470 MHz) | GPE | 9.5 | 10 | _ | dB |
| Collector Efficiency (VCC = 12.5 Vdc, P _{out} = 3.0 W, f = 470 MHz) | η | | 55 | | % |

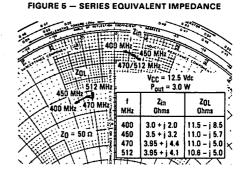


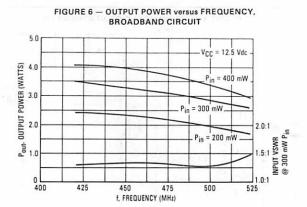




VCC. SUPPLY VOLTAGE (VOLTS)







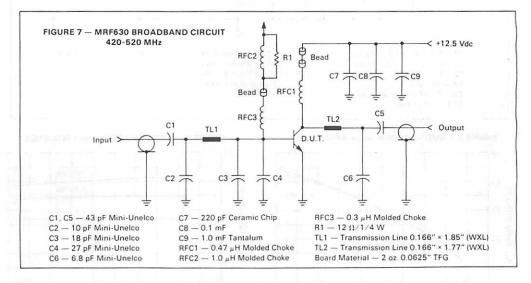
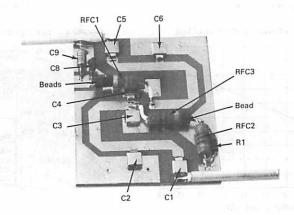


FIGURE 8 - BROADBAND CIRCUIT



MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|--------|--------------|---------------|
| Collector-Emitter Voltage | VCEO | 15 | Vdc |
| Collector-Base Voltage | VCBO | 25 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | lc | 30 | mAdc |
| Total Device Dissipation @ T _C = 25°C Derate above 25°C | PD | 0.375 3.3 | Watt mW/°C |
| Storage Temperature | Tota | 150 | •℃ |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|--------|-----|------|
| Thermal Resistance, Junction to Ambient | ReJA | 300 | °C/W |

MRF901

CASE 317-01, STYLE 2
HIGH FREQUENCY TRANSISTOR
NPN SILICON

| ELECTRICAL CHARACTERISTICS (T _A = 25°C unless otherwise noted.) Characteristic | | | | | |
|--|-----------------|-----|-----|-----|------|
| | Symbol | Min | Тур | Max | Unit |
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 15 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.1 mAdc, IE = 0) | V(BR)CBO | 25 | _ | - | Vdc |
| Emitter-Base Breakdown Voltage (IE = 0.1 mAdc, IC = 0) | V(BR)EBO | 2.0 | | - | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, Ig = 0) | ICBO | _ | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | • | | • |
| DC Current Gain (IC = 5.0 mAdc, VCE = 5.0 Vdc) | hFE | 30 | 80 | 200 | _ |
| SMALL SIGNAL CHARACTERISTICS | | | | | • |
| Current-Gain — Bandwidth Product (IC = 15 mAdc, VCE = 10 Vdc, f = 1.0 GHz) | ÍΤ | _ | 4.5 | _ | GHz |
| Collector-Base Capacitance (V _{CB} = 10 Vdc, t _E = 0, f = 1.0 MHz) | C _{cb} | _ | 0.4 | 1.0 | pF |
| Noise Figure (IC = 5.0 mAdc, VCE = 6.0 Vdc, f = 1.0 GHz) | NF | _ | 2.0 | 2.5 | dB |
| FUNCTIONAL TEST (FIGURE 1) | | | | | |
| Common-Emitter Amplifier Power Gain (VCC = 6.0 Vdc, IC = 5.0 mA, f = 1.0 GHz) | Gpe | 10 | 12 | _ | dB |
| Third Order Intercept (IC = 5.0 mAdc, VCE = 6.0 Vdc, f = 0.9 GHz) | <u> </u> | _ | +23 | _ | dBm |

FIGURE 1 - 1.0 GHz TEST CIRCUIT SCHEMATIC

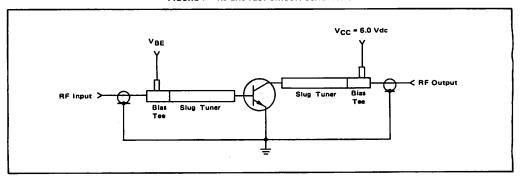


FIGURE 2 — MAXIMUM UNILATERAL GAIN versus FREQUENCY

25

25

15 mA

15 mA

15 mA

10 mA

10 mA

10 mA

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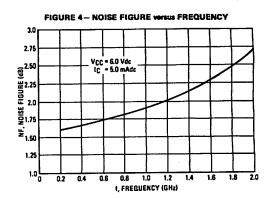
10 mA

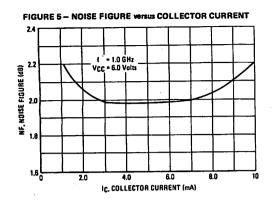
10 mA

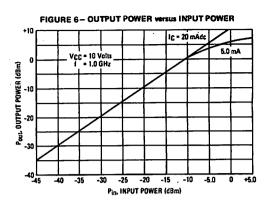
10 mA

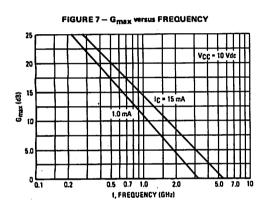
10 m

0.5 0.7 1.0 I, FREQUENCY (GHz)









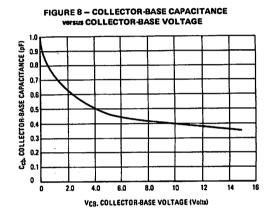


TABLE 1 - S11

| FREQUEN | CY (MHz) | 20 | 10 | 50 | X 0 | 10 | 00 | 15 | 00 | 2000 | |
|----------|----------|-----------------|------|-----------------|------------|-----|------|-----------------|------|-----------------|------|
| Vcc | lc | S ₁₁ | Lφ | S ₁₁ | Lφ | S11 | Lφ | S ₁₁ | 44 | S ₁₁ | Lφ |
| | 1.0mA | .83 | -54 | .65 | -110 | .61 | -153 | .62 | +177 | .65 | +157 |
| | 2.5 | .72 | -74 | .57 | -132 | .56 | -171 | .58 | +165 | .61 | +148 |
| | 5.0 | .63 | -98 | .55 | -151 | .55 | +174 | .58 | +154 | .60 | +140 |
| 1 Volt | 10 | .55 | -130 | .55 | -170 | .56 | +164 | .59 | +148 | .61 | +135 |
| | 15 | .55 | -147 | .56 | -178 | .58 | +160 | .62 | +145 | .63 | +133 |
| | 20 | .58 | -165 | .60 | +174 | .62 | +158 | .65 | +144 | .67 | +132 |
| | 1.0 | .85 | -48 | .68 | -100 | .61 | -149 | .62 | +178 | .65 | +156 |
| | 2.5 | .75 | -63 | .58 | -121 | .53 | -169 | .56 | +164 | .59 | +146 |
| | 5.0 | .64 | -82 | .52 | -139 | .51 | +177 | .54 | +156 | .57 | +139 |
| 3 Volts | 10 | .53 | -112 | .48 | -160 | .51 | +167 | .54 | +149 | .56 | +134 |
| | 15 | .49 | -126 | .48 | -168 | .52 | +162 | .55 | +145 | .57 | +132 |
| | 20 | .48 | -137 | .49 | -173 | .53 | +160 | .56 | +145 | .58 | +131 |
| | 1.0 | .87 | -45 | .71 | -94 | .60 | -148 | .60 | +179 | .63 | +156 |
| | 2.5 | .77 | -68 | .60 | -114 | .52 | -164 | .55 | +168 | .57 | +148 |
| | 5.0 | .66 | -75 | .52 | -132 | .48 | -177 | .52 | +159 | .54 | +142 |
| 6 Volts | 10 | .53 | -101 | .46 | -151 | .47 | +171 | .50 | +152 | .53 | +137 |
| | 15 | .47 | -115 | .45 | -162 | .47 | +166 | .51 | +148 | .53 | +135 |
| | 20 | .46 | -125 | .45 | -167 | .48 | +163 | .52 | +147 | .54 | +134 |
| | 1.0 | .88 | -43 | .72 | -91 | .60 | -145 | .60 | -178 | .63 | +158 |
| | 2.5 | .79 | -55 | .60 | -109 | .52 | -160 | .54 | +170 | .57 | +150 |
| | 5.0 | .68 | -70 | .50 | -130 | .47 | -175 | .50 | +160 | .53 | +143 |
| 10 Voits | 10 | .55 | -93 | .45 | -147 | .45 | +173 | .48 | +154 | .52 | +138 |
| | 15 | .50 | -107 | .43 | -158 | .44 | +168 | .49 | +151 | .52 | +136 |
| | 20 | .47 | -116 | .43 | -163 | .45 | +166 | .49 | +150 | .52 | +136 |

TABLE II - S21

| FREQUE | NCY (MHz) | | 200 | 50 |)0 | 10 | 00 | 15 | 00 | 2000 | |
|----------|-----------|-----------------|------|-----------------|------------|-----------------|------------|-----------------|-----|-----------------|-----|
| VCC | <u>ي</u> | S ₂₁ | 40 | S ₂₁ | L Ø | S ₂₁ | L Ø | S ₂₁ | Lφ | S ₂₁ | 4 |
| | 1.0mA | 4.2 | +140 | 2.7 | +104 | 1.4 | +73 | .96 | +52 | .77 | +39 |
| | 2.5 | 7.2 | +130 | 3.9 | +98 | 2.1 | +73 | 1.4 | +55 | 1.1 | +42 |
| 1 Volt | 5.0 | 9.9 | 1121 | 4.8 | +92 | 2.6 | +72 | 1.8 | +57 | 1.4 | +44 |
| 1 Voit | 10 | 12.0 | +109 | 5.2 | +87 | 2.8 | +70 | 1.9 | +57 | 1.5 | +44 |
| | 15 | 11.4 | +103 | 4.9 | +84 | 2.7 | +68 | 1.8 | +55 | 1.4 | +42 |
| | 20 | 6.3 | +96 | 2.6 | +81 | 1.9 | +65 | 1.3 | +52 | 1.0 | +41 |
| | 1.0 | 4.5 | +144 | 3.0 | +110 | 1.5 | +78 | 1.0 | +56 | .82 | +43 |
| | 2.5 | 7.8 | +136 | 4.5 | +103 | 2.5 | +76 | 1.7 | +58 | 1.3 | +45 |
| 21/-10- | 5.0 | 11.2 | +127 | 5.7 | +97 | 3.0 | +74 | 2.0 | +58 | 1.6 | +45 |
| 3 Volts | 10 | 14.9 | +116 | 6.8 | +91 | 3.4 | +72 | 2.3 | +58 | 1.8 | +45 |
| | 15 | 16 | +111 | 7.0 | +88 | 3.6 | +70 | 2.4 | +57 | 1.8 | +45 |
| | 20 | 16.4 | +108 | 7.0 | +87 | 3.5 | +69 | 2.4 | +56 | 1.8 | +44 |
| | 1.0 | 4.5 | +146 | 3.1 | +113 | 1.8 | +81 | 1.2 | +60 | .96 | +46 |
| | 2.5 | 7.8 | +139 | 4.8 | +106 | 2.7 | +78 | 1.8 | +60 | 1.4 | +46 |
| 6 Volts | 5.0 | 11.6 | +130 | 6.2 | +99 | 3.3 | +75 | 2.2 | +60 | 1.7 | +47 |
| o voits | 10 | 15.9 | +120 | 7.5 | +92 | 3.8 | +73 | 2.5 | +59 | 1.9 | +47 |
| | 15 | 17.2 | +114 | 7.7 | +90 | 4.0 | +71 | 2.6 | +58 | 2.0 | +46 |
| | 20 | 17.7 | +110 | 7.8 | +88 | 4.0 | +70 | 2.6 | +57 | 2.0 | +45 |
| | 1.0 | 4.5 | +147 | 3.2 | +114 | 1.8 | +82 | 1.2 | +61 | .96 | +47 |
| | 2.5 | 7.8 | +140 | 4.9 | +107 | 2.7 | +79 | 1.8 | +61 | 1.4 | +47 |
| **** | 5.0 | 11.7 | +132 | 6.4 | +100 | 3.5 | +75 | 2.3 | +60 | 1.8 | +48 |
| 10 Volts | 10 | 15.9 | +121 | 7.6 | +93 | 4.0 | +73 | 2.6 | +58 | 2.0 | +47 |
| | 15 | 17.4 | +115 | 8.0 | +90 | 4.0 | +71 | 2.7 | +57 | 2.0 | +46 |
| | 20 | 17.8 | +112 | 8.0 | +88 | 4.0 | +70 | 2.6 | +56 | 2.0 | +45 |

TABLE III - S12

| FREQUEN | ICY (MHz) | 20 | 0 | 50 | 0 | 100 | 00 | 15 | 00 | 200 |)0 |
|----------|-----------|-------|-----|-------|-------------|-------|-----|-------------|-----|-------|-----|
| Vcc | ပ | 15121 | 4 | 18121 | L \$ | 15121 | Lø | 1512! | 4 | 18121 | 4 |
| | 1.0mA | .09 | +57 | .14 | +32 | .15 | +17 | .15 | +13 | .13 | +21 |
| ' | 2.5 | .08 | +49 | .10 | +32 | .12 | +27 | .13 | +32 | .14 | +40 |
| 1 Volt | 5.0 | .06 | +43 | .08 | +35 | .10 | +42 | .13 | +48 | .16 | +51 |
| | 10 | .05 | +42 | .06 | +45 | .09 | +54 | .13 | +57 | .17 | +57 |
| | 15 | .04 | +43 | .06 | +50 | .09 | +60 | .13 | +60 | .18 | +60 |
| | 20 | .83 | +41 | .05 | +55 | .09 | +63 | .14 | +64 | .18 | +62 |
| | 1.0 | .06 | +61 | .10 | +37 | .13 | +21 | .12 | +20 | .10 | +31 |
| | 2.5 | .06 | +57 | .08 | +36 | .09 | +33 | `.10 | +40 | .12 | +49 |
| 3 Volts | 5.0 | .05 | +51 | .07 | +39 | .08 | +45 | .11 | +52 | .14 | +56 |
| 2 AOUR | 10 | .04 | +49 | .05 | +49 | .08 | +56 | .11 | +61 | .15 | +61 |
| | 15 | .03 | +49 | .05 | +55 | .08 | +62 | .12 | +64 | .15 | +64 |
| | 20 | .03 | +52 | .04 | +59 | .08 | +65 | .12 | +65 | .15 | +65 |
| | 1.0 | .05 | +63 | .09 | +40 | .10 | +26 | .09 | +29 | .09 | +43 |
| | 2.5 | .05 | +59 | .07 | +39 | .08 | +37 | .09 | +45 | .11 | +55 |
| 6 Volts | 5.0 | .04 | +55 | .05 | +42 | .07 | +48 | .09 | +56 | .12 | +62 |
| 0.40/17 | 10 | .03 | +50 | .04 | +51 | .07 | +58 | .10 | +64 | .13 | +66 |
| | 15 | .02 | +53 | .04 | +55 | .07 | +64 | .10 | +67 | .13 | +68 |
| | 20 | .03 | +54 | .04 | +60 | .07 | +66 | .10 | +69 | .13 | +69 |
| | 1.0 | .05 | +65 | .08 | +41 | .09 | +28 | .08 | +32 | .08 | +48 |
| | 2.5 | .04 | +59 | .06 | +42 | .07 | +38 | .08 | +48 | .09 | +59 |
| 10 Volts | 5.0 | .03 | +57 | .05 | +44 | .07 | +51 | .08 | +60 | .11 | +65 |
| IO VOITS | 10 | .03 | +54 | .04 | +51 | · .06 | +60 | .09 | +66 | .12 | +69 |
| | 15 | .03 | +52 | .04 | +55 | .06 | +64 | .09 | +68 | .12 | +70 |
| | 20 | .02 | +54 | .03 | +59 | .06 | +66 | .09 | +69 | .12 | +71 |

TABLE IV - S22

| FREQUEN | CY (MHz) | 20 | 0 | 50 | 0 | 10 | 00 | 15 | 00 | 2000 | |
|----------|----------|------------------|---------|-----------------|-----|-----------------|------------|-------|-------|-----------------|------|
| Vcc | lc | \$ ₂₂ | <u></u> | S ₂₂ | Lφ | S ₂₂ | L Ø | 1S221 | 44 | S ₂₂ | Ĺφ |
| | 1.0mA | .88 | -23 | .66 | -41 | .57 | -56 | .54 | -76 | .53 | -96 |
| | 2.5 | .76 | -34 | .48 | -60 | .40 | -61 | .37 | -78 | .37 | -98 |
| | 5.0 | .61 | -45 | .34 | -58 | .25 | -67 | .23 | -84 | .24 | -103 |
| 1 Volt | 10 | .42 | -60 | .20 | -70 | .15 | -75 | .14 | -95 | .16 | -115 |
| | 15 | .31 | -67 | .15 | -77 | .11 | -83 | .11 | -105 | .14 | -125 |
| | 20 | .16 | -72 | .09 | -82 | .10 | -92 | .12 | -119 | .16 | -140 |
| | 1.0 | .91 | -18 | .75 | -32 | .66 | -47 | .62 | -65 | .60 | -82 |
| | 2.5 | .83 | -25 | .60 | -38 | .47 | -50 | .44 | · -84 | .43 | -81 |
| | 5.0 | .72 | -32 | .47 | -41 | .36 | -50 | .34 | -64 | .33 | -80 |
| 3 Volts | 10 | .56 | -40 | .34 | -42 | .27 | -49 | .25 | -62 | .25 | -78 |
| l | 15 | .48 | -43 | .30 | -41 | .23 | -46 | .21 | -60 | .22 | -76 |
| | 20 | .43 | -43 | .27 | -39 | .22 | -44 | .21 | -58 | .22 | -75 |
| | 1.0 | .93 | -15 | .79 | -27 | .68 | -42 | .65 | -57 | .63 | -74 |
| | 2.5 | .87 | -20 | .67 | -31 | .55 | -42 | .52 | -56 | .51 | -71 |
| | 5.0 | .77 | -26 | .55 | -34 | .45 | -41 | .43 | -53 | .42 | -68 |
| 6 Volts | 10 | .63 | -32 | .43 | -33 | .37 | -38 | .36 | -50 | .35 | -64 |
| | l 16 | .57 | -33 | .40 | -31 | .35 | -35 | .34 | -47 | .33 | -62 |
| | 20 | .53 | -33 | .38 | -29 | .34 | -34 | .33 | -46 | .33 | -61 |
| | 1.0 | .94 | -13 | .82 | -25 | .73 | -38 | .69 | -53 | .67 | -69 |
| | 2.5 | .89 | -18 | .70 | -28 | .60 | -38 | .57 | -51 | .56 | -66 |
| | 5.0 | .81 | -23 | .60 | -29 | .50 | -37 | .48 | -48 | .47 | -61 |
| 10 Volts | 10 | .68 | -27 | .50 | -28 | .44 | -34 | .43 | -45 | .42 | -58 |
| | 15 | .62 | -28 | .47 | -26 | .43 | -30 | .42 | -42 | .42 | -56 |
| | 20 | .59 | -27 | .46 | -24 | .43 | -30 | .42 | -42 | .42 | -56 |

CASE 20-03, STYLE 10 TO-72 (TO-206AF)

HIGH FREQUENCY TRANSISTOR

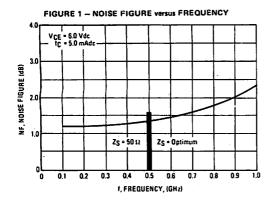
NPN SILICON

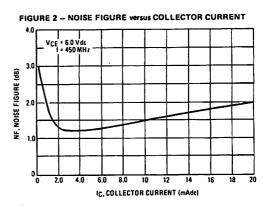
MAXIMUM RATINGS

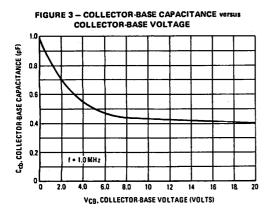
| INPOLINGIN ILATINGS | | | |
|---|------------------|-------------|---------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | · VCEO | 15 | Vdc |
| Collector-Base Voltage | VCBO | 25 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | IC | 30 | mAdc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 0.2 1.14 | Watt mW/°C |
| Storage Temperature | T _{sto} | -65 to +200 | က္ |

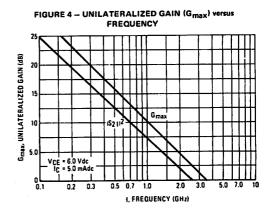
| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|------------------|-----|------------|-----|------|
| OFF CHARACTERISTICS | | | - | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, Ig = 0) | V(BR)CEO | 15 | | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.1 mAdc, IE = 0) | V(BR)CBO | 25 | _ | | Vdc |
| Emitter-Base Breakdown Voltage (IE = 0.1 mAdc, IC = 0) | V(BR)EBO | 3.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, I _E = 0) | ICBO | - | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 5.0 mAdc, V _{CE} = 5.0 Vdc) | hFE | 30 | _ | 200 | - |
| SMALL SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 15 mAdc, VCE = 10 Vdc, f = 1.0 GHz) | fŢ | - | 4.0 | _ | GHz |
| Collector-Base Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | C _{cb} | _ | _ | 1.0 | рF |
| Noise Figure (I _C = 5.0 mAdc, V _{CE} = 6.0 Vdc, f = 450 MHz) (I _C = 5.0 mAdc, V _{CE} = 6.0 Vdc, f = 1.0 GHz) | NF | 1 1 | 1.5 2.5 | _ | dB |
| FUNCTIONAL TEST | | | | | |
| Maximum Available Power(1) (IC = 5.0 mAdc, VCE = 6.0 Vdc, f = 450 MHz) (IC = 5.0 mAdc, VCE = 6.0 Vdc, f = 1.0 GHz) | G _{max} | = | 16 10 | = | dB |

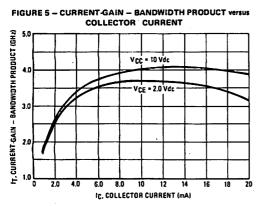
(1)
$$G_{\text{max}} = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$$











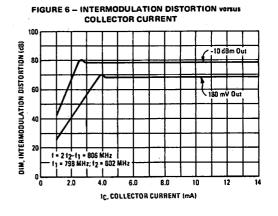


TABLE 1 - S₁₁ PARAMETERS

| Frequenc | y (MHz) | I | | | | | | Τ | | г | |
|----------|---------|-------|------|------|------|-------|------|--------|------|-------|------|
| VCC | lc | 10 | 0 | 20 | ю | 50 | 00 | 80 | 0 | 10 | 00 |
| (Volts) | (mA) | S11 | 4 | S11 | Lφ | S11 | LØ | \$11 | Lφ | S11 | 4 |
| 1.0 | 1,0 | 0.941 | -22 | 0.85 | -43 | 0.57 | -91 | 0.37 | -128 | 0.30 | -151 |
| | 2.5 | 0.85 | -31 | 0.67 | -57 | 0.35 | -102 | 0.20 | -136 | 0.14 | -157 |
| | 5.0 | 0.69 | -44 | 0.46 | -71 | 0.21 | -109 | 0.10 | -144 | 0.069 | -166 |
| | 10 | 0.45 | -67 | 0.28 | -94 | 0.13 | -136 | 0.087 | 172 | 0.075 | 145 |
| | 15 | 0.37 | -110 | 0.31 | -145 | 0.26 | 170 | 0.27 | 139 | 0.27 | 122 |
| | 30 | 0.71 | ~178 | 0.71 | 169 | 0.68 | 144 | 0.68 | 121 | 0.65 | 107 |
| 3.0 | 1.0 | 0.94 | -19 | 0.87 | -37 | 0.61 | -80 | 0.39 | -114 | 0.30 | -134 |
| | 2.5 | 0.87 | -26 | 0.71 | -47 | 0.39 | -84 | 0.21 | -106 | 0.15 | -115 |
| | 5.0 | 0.74 | -34 | 0.52 | -55 | 0.25 | -77 | 0.13 | -82 | 0.109 | -79 |
| | 10 | 0.55 | -42 | 0.35 | -58 | 0.18 | -66 | 0.11 | -60 | 0.105 | -55 |
| | 15 | 0.46 | -46 | 0.28 | -59 | 0.15 | -64 | 0.096 | -55 | 0.092 | -49 |
| | 30 | 0.28 | -95 | 0.21 | -134 | 0.16 | 175 | 0.17 | 135 | 0.17 | 116 |
| 6.0 | 1.0 | 0.95 | -18 | 0.88 | -35 | 0.63 | -76 | 0.40 | -108 | 0.30 | -126 |
| | 2.5 | 0.89 | -23 | 0.74 | -43 | 0.42 | -77 | 0.23 | -94 | 0.17 | -100 |
| | 5.0 | 0.77 | -31 | 0.56 | -49 | 0.29 | -67 | 0.18 | -69 | 0.15 | -66 |
| | 10 | 0.61 | -37 | 0.40 | -50 | 0.23 | -55 | 0.16 | -51 | 0.16 | -50 |
| | 15 | 0.52 | 40 | 0.34 | -51 | 0.20 | -52 | . 0.15 | -47 | 0.15 | -47 |
| | 30 | 0.36 | -55 | 0.21 | -70 | 0.098 | -77 | 0.037 | -59 | 0.033 | -27 |
| 10 | 1.0 | 0.96 | -17 | 0.89 | -33 | 0.65 | -73 | 0.41 | -103 | 0,31 | -121 |
| | 2.5 | 0.89 | -22 | 0.76 | -41 | 0.44 | -73 | 0.25 | -88 | 0.18 | -93 |
| | 5.0 | 0.79 | -28 | 0.59 | -46 | 0.32 | -63 | 0.20 | -65 | 0.18 | -63 |
| | 10 | 0.64 | -34 | 0.44 | -47 | 0.26 | -52 | 0.19 | -49 | 0.18 | -49 |
| | 15 | 0.57 | -37 | 0.38 | -48 | 0.23 | -49 | 0.18 | -46 | 0.17 | -46 |
| | 30 | 0.41 | -51 | 0.24 | -64 | 0.12 | -67 | 0.061 | -52 | 0.055 | -36 |

TABLE 2 - S21 PARAMETERS

| Frequenc | y (MHz) . | | | | | | | T | | | |
|----------|-----------|-------|-----|-------|-----|------|-----|------|----|------|----|
| Vcc | lc | 10 | 0 | 20 | 0 | 50 | 0 | 80 | 0 | 100 | ж |
| (Volts) | (mA) | S21 | LØ | S21 | Lφ | S21 | 4 | S21 | LΦ | S21 | LΦ |
| 1.0 | · 1.0 | 5.32 | 156 | 3.06 | 137 | 2.22 | 97 | 1.65 | 70 | 1,44 | 56 |
| | 2.5 | 6.79 | 146 | 5.57 | 124 | 3.15 | 86 | 2.14 | 64 | 1,81 | 52 |
| | 5.0 | 10.97 | 133 | 7.60 | 110 | 3.62 | 79 | 2.38 | 61 | 2.00 | 49 |
| | 10 | 13.16 | 118 | 8.07 | 99 | 3.60 | 74 | 2,35 | 57 | 1.96 | 46 |
| | 15 | 9.84 | 108 | 5.66 | 91 | 2.44 | 67 | 1.63 | 49 | 1.38 | 38 |
| | 30 | 1.65 | 83 | 0.88 | 69 | 0.47 | 46 | 0,43 | 37 | 0.45 | 31 |
| 3.0 | 1,0 | 3.33 | 159 | 3.11 | 142 | 2.36 | 103 | 1.79 | 76 | 1.55 | 62 |
| | 2.5 | 6.89 | 150 | 5.85 | 129 | 3.48 | 92 | 2.38 | 70 | 2.00 | 58 |
| | 5.0 | 11.49 | 138 | 8.34 | 115 | 4.12 | 84 | 2.70 | 66 | 2.25 | 55 |
| | 10 | 15.71 | 125 | 9.82 | 104 | 4.39 | 79 | 2.85 | 63 | 2.34 | 53 |
| | 15 | 16.97 | 119 | 10.05 | 100 | 4,39 | 77 | 2.83 | 61 | 2.34 | 52 |
| | 30 | 12.66 | 108 | 7.02 | 92 | 2.98 | 70 | 1.94 | 54 | 1.61 | 44 |
| 6.0 | 1,0 | 3.31 | 160 | 3.10 | 144 | 2.41 | 106 | 1.83 | 79 | 1.60 | 65 |
| | 2.5 | 6.80 | 151 | 5.85 | 131 | 3.60 | 94 | 2.46 | 77 | 2,07 | 60 |
| | 5.0 | 11.44 | 140 | 8.54 | 117 | 4.28 | 86 | 2.83 | 68 | 2.33 | 57 |
| | 10 | 15.85 | 127 | 10.14 | 107 | 4.61 | 81 | 2.96 | 65 | 2.46 | 55 |
| | 15 | 17.20 | 122 | 10.47 | 102 | 4.60 | 79 | 2.96 | 63 | 2.45 | 54 |
| | 30 | 16,37 | 113 | 9.38 | 96 | 4.00 | 75 | 2.58 | 59 | 2.14 | 49 |
| 10 | 1.0 | 3.25 | 160 | 3.08 | 145 | 2.40 | 108 | 1.83 | 81 | 1.61 | 67 |
| | 2.5 | 6.73 | 152 | 5.85 | 132 | 3,63 | 96 | 2,50 | 74 | 2.10 | 62 |
| | 5.0 | 11.19 | 142 | 8.49 | 119 | 4.34 | 88 | 2.85 | 69 | 2.37 | 59 |
| | 10 | 15.59 | 129 | 10.16 | 108 | 4.66 | 82 | 3.00 | 66 | 2,47 | 56 |
| | 15 | 17.04 | 124 | 10.49 | 104 | 4.65 | 80 | 2.99 | 64 | 2.47 | 55 |
| | 30 | 16.18 | 115 | 9.38 | 98 | 4.03 | 96 | 2.60 | 60 | 2.14 | 50 |

TABLE 3 - S12 PARAMETERS

| Frequency | (MHz) | | | | -0 -12 | | | | | | |
|-----------|-------|-------|----|-------|--------|-------|-----|-------|------|-------|----|
| Vcc | ¹c | 100 |) | 200 | | 500 | | 800 | | 100 | |
| (Volts) | (mA) | S12 | LΦ | S12 | L Ø | S12 | L Ø | S12 | Lø | S12 | LΦ |
| 1.0 | 1.0 | 0.054 | 73 | 0.097 | 61 | 0.159 | 41 | 0.184 | 36 | 0.194 | 37 |
| 1 | 2.5 | 0.051 | 69 | 0.084 | 58 | 0.140 | 50 | 0.189 | 48 | 0.220 | 46 |
| ľ | 5.0 | 0.046 | 65 | 0.072 | 60 | 0.137 | 58 | 0.201 | 53 · | 0.239 | 50 |
| 1 | 10 | 0.041 | 64 | 0.067 | 64 | 0.142 | 62 | 0.215 | 56 | 0.256 | 51 |
| \ | 15 | 0.043 | 61 | 0.070 | 63 | 0.152 | 62 | 0.230 | 55 | 0.277 | 50 |
| | 30 | 0.058 | 50 | 0.093 | 58 | 0.209 | 57 | 0.311 | 46 | 0,372 | 39 |
| 3.0 | 1.0 | 0.039 | 75 | 0.072 | 65 | 0.123 | 46 | 0.143 | 42 | 0,151 | 44 |
| 0.0 | 2.5 | 0.037 | 72 | 0.063 | 62 | 0.110 | 54 | 0.150 | 53 | 0.174 | 52 |
| | 5.0 | 0.033 | 70 | 0.055 | 64 | 0.108 | 62 | 0.160 | 58 | 0.190 | 55 |
| | 10 | 0.030 | 70 | 0.050 | 68 | 0.109 | 67 | 0.165 | 61 | 0.199 | 57 |
| 1 | 15 | 0.028 | 70 | 0.049 | 70 | 0.109 | 68 | 0,167 | 62 | 0.200 | 57 |
| | 30 | 0.026 | 68 | 0.046 | 70 | 0.105 | 69 | 0.165 | 64 | 0,200 | 61 |
| 6.0 | 1.0 | 0.032 | 76 | 0.060 | 66 | 0.106 | 49 | 0.123 | 45 | 0.131 | 48 |
| | 2.5 | 0.031 | 73 | 0.054 | 64 | 0.095 | 57 | 0.130 | 56 | 0.151 | 55 |
| 1 | 5.0 | 0.028 | 71 | 0.048 | 66 | 0.094 | 64 | 0.139 | 61 | 0.165 | 58 |
| ł | 10 | 0.026 | 71 | 0.043 | 69 | 0.094 | 68 | 0.144 | 63 | 0.172 | 59 |
| l | 15 | 0.024 | 71 | 0.042 | 71 | 0.093 | 69 | 0.144 | 64 | 0.172 | 60 |
| | 30 | 0.021 | 71 | 0.037 | 72 | 0.086 | 71 | 0.134 | 67 | 0.162 | 63 |
| 10 | 1.0 | 0.028 | 77 | 0.053 | 68 | 0,095 | 50 | 0.109 | 47 | 0.116 | 50 |
| 1 | 2.5 | 0.027 | 74 | 0.048 | 65 | 0.085 | 58 | 0.116 | 57 | 0.134 | 57 |
| | 5.0 | 0.025 | 73 | 0.043 | 67 | 0.084 | 64 | 0.125 | 62 | 0.148 | 60 |
| j | 10 | 0.023 | 72 | 0.037 | 69 | 0,084 | 69 | 0.128 | 64 | 0.153 | 61 |
| (| 15 | 0.022 | 73 | 0.037 | 70 | 0.084 | 69 | 0.128 | 65 | 0.152 | 62 |
| | 30 | 0.019 | 72 | 0.033 | 72 | 0.076 | 72 | 0,119 | 68 | 0.143 | 66 |

TABLE 4 - \$22 PARAMETERS

| Frequenc | y (MHz) | | | | | | | | | | |
|----------|---------|-------|------|-------------|-----|-------|------------|-------|------------|-------|------|
| Vcc | lc | 100 |) | 200 | _ | 500 |) | 800 | | 100 | 0 |
| (Volts) | (mA) | S22 | 4 | \$22 | 4 | S22 | Δ φ | S22 | · L Ø | S22 | 40 |
| 1.0 | 1.0 | 0.966 | -12 | 0.893 | -23 | 0.693 | -41 | 0.612 | -53 | 0.594 | -59 |
| ••• | 2.5 | 0.901 | -18 | 0.760 | -29 | 0.548 | -42 | 0.498 | -51 | 0.494 | -56 |
| | 5.0 | 0.793 | -24 | 0.619 | -32 | 0.456 | -39 | 0.429 | -49 | 0.439 | -54 |
| | 10 | 0.635 | -29 | 0.486 | -32 | 0,390 | -36 | 0.377 | -47 | 0.389 | -53 |
| | 15 | 0.453 | -29 | 0.364 | -29 | 0,313 | -34 | 0,309 | -48 | 0.321 | -14 |
| | 30 | 0.048 | -78 | 0.035 | -88 | 0.032 | -135 | 0.031 | -162 | 0.007 | -167 |
| 3.0 | 1.0 | 0.976 | -9.0 | 0.926 | -18 | 0.770 | -35 | 0.702 | -46 | 0.683 | -51 |
| | 2.5 | 0.935 | -13 | 0.828 | -23 | 0.648 | -35 | 0.608 | -43 | 0,608 | -48 |
| | 5.0 | 0.853 | -18 | 0.712 | -25 | 0.577 | -32 | 0,555 | -41 | 0.565 | -46 |
| | 10 | 0.758 | -20 | 0.629 | -23 | 0.539 | -29 | 0.529 | -39 | 0.544 | -44 |
| | 15 | 0.711 | -20 | 0.601 | -22 | 0.533 | -27 | 0.526 | -38 | 0.540 | -44 |
| | 30 | 0.631 | -15 | 0.576 | -16 | 0.548 | -25 | 0.546 | -38 | 0,558 | -45 |
| 6.0 | 1.0 | 0.982 | -8.0 | 0.939 | -16 | 0.803 | -31 | 0.742 | 42 | 0,734 | -47 |
| | 2.5 | 0.947 | -11 | 0.861 | -20 | 0.699 | -31 | 0.662 | -40 | 0.660 | -45 |
| | 5.0 | 0.882 | -15 | 0.759 | -21 | 0.633 | -29 | 0.617 | -31 | 0.627 | -43 |
| | 10 | 0.801 | -17 | 0.684 | -20 | 0.607 | -26 | 0.601 | -35 | 0.610 | -41 |
| | 15 | 0.769 | -17 | 0.667 | -19 | 0,602 | -25 | 0.601 | -35 | 0.607 | -40 |
| | 30 | 0.737 | -14 | 0.672 | -15 | 0.640 | -22 | 0.641 | -33 | 0.655 | -40 |
| 10 | 1.0 | 0.983 | -7.0 | 0.949 | -14 | 0.830 | -29 | 0.774 | -39 | 0.765 | -40 |
| | 2.5 | 0.954 | -10 | 0.880 | -18 | 0.733 | -29 | 0.698 | -37 | 0.702 | -42 |
| | 5.0 | 0.901 | -13 | 0.793 | -19 | 0.676 | -27 | 0.659 | -35 | 0.668 | -41 |
| | 10 | 0.834 | -15 | 0.725 | -18 | 0.646 | -24 | 0.646 | -33 | 0.658 | -39 |
| | 15 | 0.802 | -15 | 0.706 | -17 | 0.645 | -23 | 0.648 | -33 | 0.661 | -39 |
| | 30 | 0.776 | -13 | 0.712 | -14 | 0.678 | -22 | 0.686 | -32 | 0.699 | -38 |

CASE 26-03, STYLE 1 TO-46 (TO-206AB)

RF OSCILLATOR TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

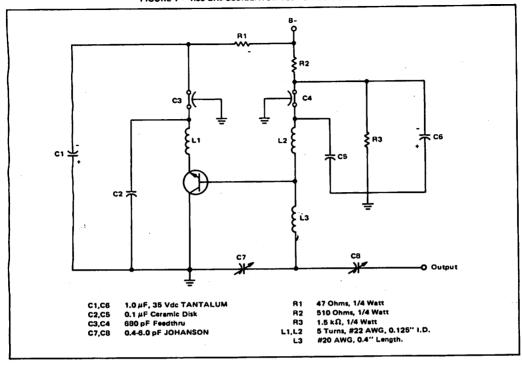
| Rating | Symbol | Value | Unit |
|--|------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 20 | Vdc |
| Collector-Base Voltage | VCBO | 35 | Vdc |
| Emitter-Base Voltage | VEBO | 3.5 | Vdc |
| Collector Current — Continuous | lc | 150 | mAdc |
| Total Device Dissipation @ T _C = 100°C Derate above 100°C | PD | 2.5 40 | Watts mW/°C |
| Storage Temperature | T _{sto} | -65 to +200 | ÷C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|--------------------------------------|------------------|-----|------|
| Thermal Resistance, Junction to Case | R _{6JC} | 25 | °C/W |

| Characteristic | Symbol | Min | Тур | Max | Unit |
|---|------------------|-----|------|-----|------|
| OFF CHARACTERISTICS | | _ | | | |
| Collector-Emitter Breakdown Voltage (I _C = 10 mAdc, I _B = 0) | V(BR)CEO | 20 | 30 | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 0.1 mAdc, I _E = 0) | V(BR)CBO | 35 | _ | - | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 0.1 mAdc, I _C = 0) | V(BR)EBO | 3.5 | 5.0 | _ | Vdc |
| Collector Cutoff Current ($V_{CB} = 20 \text{ Vdc}$, $I_E = 0$) | ІСВО | - | _ | 0.1 | mAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 100 mAdc, VCE = 10 Vdc) | hFE | 20 | 60 | 150 | - |
| SMALL SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 100 mAdc, VCE = 10 Vdc, f = 200 MHz) | fτ | _ | 2500 | _ | MHz |
| Output Capacitance (VCB = 20 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | _ | 3.0 | 5.0 | pF |
| FUNCTIONAL TEST | | | | | |
| Common-Collector Oscillator Output Power (Figure 1) (V _E = −20 Vdc, I _E ≈ 110 mAdc, f ≈ 1.68 GHz) | Pout | 400 | 500 | _ | mW |

FIGURE 1 - 1.68 GHz OSCILLATOR TEST CIRCUIT SCHEMATIC



CASE 317-01, STYLE 2
HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

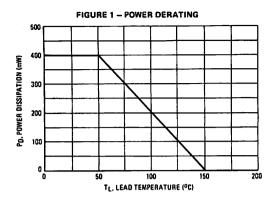
| Rating | Symbol | Value | Unit |
|---|------------------|-------------|-------------|
| Collector-Emitter Voltage | VCEO | 12 | Vdc |
| Collector-Base Voltage | V _{CBO} | 20 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Peak | lc | 40 | mAdc |
| Total Device Dissipation @ T _L = 50°C Derate above 50°C | PD | 400 4.0 | mW mW/°C |
| Storage Temperature | T _{stg} | -65 to +150 | ·c |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit | 1 |
|--------------------------------------|--------|-----|------|---|
| Thermal Resistance, Junction to Lead | RøJL | 250 | °C/W | 1 |

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|---------------------------------------|-----|-------------|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (I _C = 1.0 mAdc, I _B = 0) | V(BR)CEO | 12 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.1 mAdc, IE = 0) | V(BR)CBO | 20 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 0.1 mAdc, I _C = 0) | V(BR)EBO | 3.0 | _ | _ | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, I _E = 0) | ICBO | _ | _ | 50 | nAdc |
| ON CHARACTERISTICS | · · · · · · · · · · · · · · · · · · · | | - | | · |
| DC Current Gain (I _C = 30 mAdc, V _{CE} = 10 Vdc) | hFE | 30 | _ | 200 | |
| SMALL SIGNAL CHARACTERISTICS | | | · | | L |
| Current-Gain — Bandwidth Product (I _C = 30 mAdc, V _{CE} = 10 Vdc, f = 1.0 GHz) | fT | _ | 5.0 | _ | GHz |
| Collector-Base Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | C _{cb} | _ | 0.6 | 1.0 | pF |
| FUNCTIONAL TEST | | | | | |
| Noise Figure (I _C = 5.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 GHz) (I _C = 5.0 mAdc, V _{CE} = 10 Vdc, f = 2.0 GHz) | NF | - | 2.5 4.0 | | dB |
| Power Gain at Optimum Noise Figure (I _C = 5.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 GHz) (I _C = 5.0 mAdc, V _{CE} = 10 Vdc, f = 2.0 GHz) | G _{NF} | _ | 10 6.0 | = | dB |
| Maximum Available Power Gain(1) (IC = 30 mAdc, VCE = 10 Vdc, f = 1.0 GHz) (IC = 30 mAdc, VCE = 10 Vdc, f = 2.0 GHz) | G _{max} | | 12.5 7.5 | _ | dB |

(1)
$$G_{\text{max}} = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$$



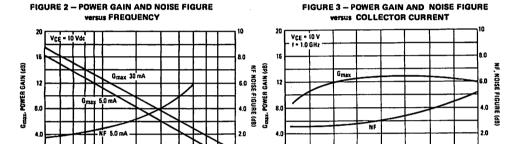


FIGURE 4 - S₁₁ PARAMETERS 2000 Frequency (MHz) 500 1000 1500 VCE lc **S11 S11** LΦ (Volts) (mA) **S11 S11** LΦ LΦ 5.0 2.0 0.66 -125 0.64 -175 0.68 160 0.73 140 0.57 -150 0.58 170 0.62 150 0.66 135 5.0 0.60 0.64 130 10 0.54 -165 0.57 160 145 0.54 ~180 0.57 155 0.60 140 0.64 125 20 140 0.65 125 30 0.54 175 0.57 155 0.61 140 0.66 -120 0.63 -170 0.67 160 0.71 10 2.0 150 135 0.60 0.64 5.0 0.56 -145 0.56 175 0.61 130 10 0.51 -160 0.53 165 0.57 145 0.57 145 0.60 130 0.49 -175 0.52 160 20 30 0.49 -175 0.53 160 0.57 145 0.61 130

IC. COLLECTOR CURRENT (mA)

0.7

f, FREQUENCY (GHz)

FIGURE 5 - S22 PARAMETERS

| Frequency (MHz) | | 500 | | 100 | 1000 | | 1500 | | 00 |
|----------------------------|------------|------|-----|------|------------|------|------|------|------|
| V _{CE} (Volts) | IC (mA) | S22 | LØ | S22 | L ø | S22 | Lø | S22 | Lø |
| 5.0 | 2.0 | 0.61 | -45 | 0.50 | -60 | 0.48 | -80 | 0.50 | -100 |
| | 5.0 | 0.40 | -55 | 0.31 | -65 | 0.30 | -85· | 0.32 | -100 |
| | 10 | 0.27 | -60 | 0.20 | -70 | 0.20 | -90 | 0.23 | -105 |
| | 20 | 0.19 | -70 | 0.13 | -75 | 0.14 | -95 | 0.17 | -110 |
| | 30 | 0.16 | -70 | 0.11 | -75 | 0.13 | -95 | 0.16 | -110 |
| 10 | 2.0 | 0.66 | -35 | 0.55 | -50 | 0.53 | -70 | 0.54 | -90 |
| | 5.0 | 0.47 | -45 | 0.38 | -50 | 0.37 | -70 | 0,38 | -75 |
| | 10 | 0.35 | -45 | 0.28 | -50 | 0.27 | -65 | 0.29 | -85 |
| | 20 | 0.26 | -45 | 0.22 | -50 | 0.22 | -65 | 0.24 | -80 |
| | 30 | 0.25 | -40 | 0.21 | -45 | 0.22 | -60 | 0.24 | -80 |

FIGURE 6 - S21 PARAMETERS

| Frequency (MHz) | | 500 | | 1000 | | 1500 | | 2000 | |
|----------------------------|----------------|------|------------|------|----|------|----|------|------|
| V _{CE} (Volts) | I _C | S21 | L Φ | S21 | Lφ | S21 | LΦ | S21 | LΦ |
| 5.0 | 2.0 | 3.24 | 100 | 1.84 | 70 | 1.23 | 50 | 0.96 | 35 |
| | 5.0 | 4.85 | 90 | 2.60 | 70 | 1.76 | 50 | 1.38 | 40 |
| | 10 | 5.78 | 85 | 3.04 | 70 | 2.05 | 50 | 1.61 | 40 |
| | 20 | 6.40 | 85 | 3.30 | 65 | 2.23 | 50 | 1.24 | 40 |
| | 30 | 6.47 | 80 | 3.35 | 65 | 2.26 | 50 | 1.76 | 40 |
| 10 | 2.0 | 3.42 | 100 | 1.95 | 70 | 1,31 | 50 | 1.01 | 35 |
| | 5.0 | 5.20 | 95 | 2.80 | 70 | 1.89 | 50 | 1.45 | 40 |
| | 10 | 6.22 | 90 | 3.28 | 70 | 2.20 | 55 | 1.71 | - 40 |
| | 20 | 6.82 | 85 | 3.55 | 65 | 2.37 | 55 | 1.84 | 40 |
| | 30 | 6.90 | 85 | 3.55 | 65 | 2.36 | 50 | 1.81 | 40 |

FIGURE 7 - S₁₂ PARAMETERS

| Frequenc | y (MHz) | 500 | | 1000 | | 1500 | | 2000 | |
|----------------------------|------------------------|------|----|------|------|------|----|------|---------------|
| V _{CE} (Volts) | I _C (mA) | S12 | 10 | S12 | . Lø | S12 | Lø | S12 | ل ــــ |
| 5.0 | 2.0 | 0.11 | 30 | 0.12 | 25 | 0.11 | 35 | 0.13 | 50 |
| | 5.0 | 0.08 | 40 | 0.10 | 45 | 0.13 | 55 | 0.17 | 55 |
| | 10 | 0.07 | 50 | 0.10 | 55 | 0.14 | 60 | 0.19 | 60 |
| | 20 | 0.06 | 60 | 0.11 | 65 | 0.15 | 65 | 0.20 | 60 |
| | 30 | 0.06 | 65 | 0.11 | 65 | 0.15 | 65 | 0.20 | 60 |
| 10 | 2.0 | 0.10 | 35 | 0.10 | 30 | 0.10 | 40 | 0.12 | 55 |
| | 5.0 | 0.07 | 40 | 0.09 | 45 | 0.12 | 55 | 0.15 | 60 |
| | 10 | 0.06 | 50 | 0.09 | 55 | 0.13 | 60 | 0.17 | 60 |
| | 20 | 0.06 | 60 | 0.10 | 65 | 0.13 | 65 | 0.18 | 60 |
| | 30 | 0.06 | 60 | 0.10 | 65 | 0.14 | 65 | 0.18 | 65 |

MAXIMUM RATINGS

| MAXIMOM DATINGS | | | |
|--|------------------|-------------|-------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 12 | Vdc |
| Collector-Base Voltage | VCBO | 20 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Peak | lc | 50 | mAdc |
| Total Device Dissipation @ T _C = 75°C Derate above 75°C | PD | 500 4.0 | mW mW/°C |
| Storage Temperature | T _{sta} | -65 to +200 | °C |

THERMAL CHARACTERISTICS

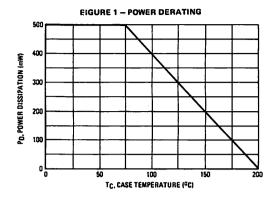
| *************************************** | | | |
|---|--------|-----|------|
| Characteristic | Symbol | Max | Unit |
| Thermal Resistance, Junction to Case | RAIC | 250 | °C/W |

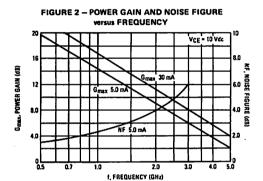
MRF912

CASE 303-01, STYLE 1
HIGH FREQUENCY TRANSISTOR
NPN SILICON

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|------------------|-----|--------------|------------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, IB = 0) | V(BR)CEO | 12 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (I _C = 0.1 mAdc, I _E = 0) | V(BR)CBO | 20 | _ | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 0.1 mAdc, I _C = 0) | V(BR)EBO | 3.0 | _ | . – | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) | ІСВО | _ | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (I _C = 30 mAdc, V _{CE} = 10 Vdc) | hFE | 30 | _ | 200 | _ |
| SMALL SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (IC = 30 mAdc, VCE = 10 Vdc, f = 1.0 GHz) | fτ | l | 5.0 | - | GHz |
| Collector-Base Capacitance (VCB = 10 Vdc, IE = 0, f = 1.0 MHz) | C _{cb} | 1 | 0.6 | 1.0 | pF |
| FUNCTIONAL TEST | | | | | |
| Noise Figure (I _C = 5.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 GHz) (I _C = 5.0 mAdc, V _{CE} = 10 Vdc, f = 2.0 GHz) | NF | 1.1 | 2.5 4.0 | 3.0 | dB |
| Power Gain at Optimum Noise Figure (t _C = 5.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 GHz) (t _C = 5.0 mAdc, V _{CE} = 10 Vdc, f = 2.0 GHz) | G _{NF} | _ | 12 7.0 | | dB |
| Maximum Available Power Gain(1) (IC = 30 mAdc, VCE = 10 Vdc, f = 1.0 GHz) (IC = 30 mAdc, VCE = 10 Vdc, f = 2.0 GHz) | G _{max} | 14 | 16.5 11.0 | - | dB |

(1)
$$G_{\text{max}} = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$$





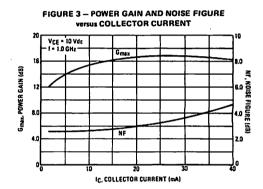


FIGURE 4 - S₁₁ PARAMETERS

| Frequency (MHz) 500 | | 90 | 1000 | | 15 | i00 | 2000 | | |
|---------------------|------|-------|------|------|------|------|------|------|-----|
| VCE | lc | • | | • | | | | | |
| (Volts) | (mA) | S11 | LΦ | S11 | LØ | S11 | LØ | S11_ | LΦ |
| 5.0 | 2.0 | 0.76 | -120 | 0.74 | -160 | 0.76 | -175 | 0.79 | 175 |
| | 5.0 | 0.72 | -145 | 0.73 | -170 | 0.75 | 175 | 0.77 | 165 |
| | 10 | 0.71 | -160 | 0.74 | 180 | 0.75 | 170 | 0.77 | 160 |
| | 20 | 0.73 | -170 | 0.75 | 175 | 0.77 | 165 | 0.79 | 155 |
| | 30 | 0.74 | -175 | 0.76 | 170 | 0.78 | 165 | 0.81 | 155 |
| | 40 | .0.74 | -180 | 0.76 | 165 | 0.79 | 155 | 0.81 | 145 |
| | 50 | 0.74 | 180 | 0.77 | 165 | 0.79 | 155 | 0.82 | 145 |
| 10 | 2.0 | 0.77 | -115 | 0.74 | -155 | 0.76 | -170 | 0.78 | 175 |
| | 5.0 | 0.71 | -140 | 0.72 | -170 | 0.73 | 175 | 0.75 | 165 |
| | 10 | 0.69 | -155 | 0.71 | -175 | 0.73 | 170 | 0.75 | 165 |
| | 20 | 0.69 | -165 | 0.72 | 175 | 0.74 | 165 | 0.76 | 160 |
| | 30 | 0.70 | -170 | 0.73 | 175 | 0.75 | 165 | 0.77 | 160 |
| | 40 | 0.69 | -175 | 0.72 | 165 | 0.75 | 155 | 0.78 | 145 |
| | 50 | 0.70 | -175 | 0.73 | 165 | 0.76 | 155 | 0.80 | 145 |

FIGURE 5 - S22 PARAMETERS

| Frequenc | y (MHz) | 50 |) | 100 |)0 | 150 | ю | 200 | 90 |
|----------------------------|------------------------|------|------|------|------|------|------|------|------|
| V _{CE} (Volts) | I _C (mA) | S22 | LΦ | S22 | ĹΦ | S22 | LΦ | S22 | LΦ |
| 5.0 | 2.0 | 0.66 | -50 | 0.57 | -70 | 0.57 | -95 | 0.61 | -115 |
| | 5.0 | 0.45 | -65 | 0.37 | -85 | 0.39 | ~105 | 0.44 | ~120 |
| - 1 | 10 | 0.33 | -80 | 0.27 | -100 | 0.30 | -115 | 0.35 | -130 |
| į | 20 | 0.24 | -95 | 0.21 | -115 | 0.24 | -125 | 0.29 | ~135 |
| | 30 | 0.21 | -100 | 0.18 | -120 | 0.22 | -125 | 0.28 | -135 |
| | . 40 | 0.18 | -100 | 0.16 | -115 | 0.20 | -125 | 0.27 | -135 |
| | 50 | 0.17 | -95 | 0.16 | -110 | 0.21 | -120 | 0.28 | -135 |
| 10 | 2.0 | 0.71 | -45 | 0.62 | -65 | 0.62 | -85 | 0.64 | ~105 |
| | 5.0 | 0.51 | -55 | 0.43 | -70 | 0.44 | -90 | 0.48 | -105 |
| | 10 | 0.37 | -60 | 0.31 | -75 | 0.33 | -95 | 0.38 | -110 |
| - 1 | 20 | 0.27 | -70 | 0.23 | -80 | 0.26 | -95 | 0.32 | -115 |
| - 1 | 30 | 0.23 | -65 | 0.21 | -80 | 0.25 | -95 | 0.31 | -110 |
| | 40 | 0.23 | -60 | 0.22 | -70 | 0.25 | -90 | 0.32 | -110 |
| | 50 | 0.24 | -50 | 0.24 | -65 | 0.28 | -90 | 0.34 | -105 |

FIGURE 6 - S21 PARAMETERS

| E | (84U-) | | | | <u> </u> | | 00 | 20 | FIGURE 6 - S ₂₁ PARAMETERS Frequency (MHz) 500 1000 1500 2000 | | | | | | | | | | | | |
|----------------------------|-------------|------|------------|--------|----------|------|------------|-------------|---|--|--|--|--|--|--|--|--|--|--|--|--|
| | CY WHEET | | | 10 | 100 | 13 | 00 | 20 | 00 | | | | | | | | | | | | |
| V _{CE} (Volts) | IC (mA) | S21 | Δ Φ | S21 | ۷.0 | S21 | Δ Φ | S21 | Δ Φ | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| 5.0 | 2.0 | 3.52 | 102 | 1.97 | 70 | 1.33 | 50 | 0.99 | 35 | | | | | | | | | | | | |
| | 5.0 | 5.61 | 95 | 2.96 | 70 | 1.98 | -50 | 1.50 | 35 | | | | | | | | | | | | |
| | 10 | 6.84 | 90 | 3.55 | 70 | 2.35 | 55 | 1.78 | 40 | | | | | | | | | | | | |
| | 20 | 7.65 | 85 | 3.94 | 65 | 2.59 | 50 | 1.96 | 40 | | | | | | | | | | | | |
| | 30 | 7.93 | - 85 | 4.02 | 65 | 2.63 | 50 | 1.98 | 40 | | | | | | | | | | | | |
| | 40 | 7.87 | 80 | 3.95 | 65 | 2.57 | 45 | 1.92 | 30 | | | | | | | | | | | | |
| | 50 | 7.65 | 80 | 3.86 | 60 | 2.48 | 45 | 1.86 | 30 | | | | | | | | | | | | |
| 10 | 2.0 | 3.70 | 105 | . 2.12 | 75 | 1.43 | 50 | 1.07 | 35 | | | | | | | | | | | | |
| | 5.0 | 6.09 | 95 | 3.24 | 70 | 2.17 | 50 | 1.62 | 35 | | | | | | | | | | | | |
| | 10 | 7.53 | 90 | 3.91 | 70 | 2.58 | 55 | 1.96 | 40 | | | | | | | | | | | | |
| | 20 | 8.54 | 85 | 4.38 | 70 | 2.86 | 55 | 2.17 | 40 | | | | | | | | | | | | |
| | 30 | 8.79 | 85 | 4.45 | 65 | 2.92 | 50 | 2.17 | 40 | | | | | | | | | | | | |
| | 40 | 8.58 | 80 | 4.32 | 65 | 2.80 | 45 | 2.08 | 30 | | | | | | | | | | | | |
| | 50 | 8.30 | 80 | 4.15 | 60 | 2.69 | 45 | 1.98 | 30 | | | | | | | | | | | | |

FIGURE 7 - S₁₂ PARAMETERS

| Frequenc | y (MHz) | - 6 | 00 | 10ne / - 51 | 000 | | 500 | 20 | 100 |
|----------|---------|-------------|----|-------------|-----|------|-----|------|-----|
| | | | | • | - | | | | |
| VCE | lc | ľ | | | | i I | 1 | ſ | ļ . |
| (Volts) | (mA) | S12 | LΦ | S12 | 4.0 | S12 | LΦ | S12 | LΦ |
| 5.0 | 2.0 | 0,11 | 25 | 0.11 | 5.0 | 0.10 | -5 | 0.09 | -5 |
| | 5.0 | 0.07 | 25 | 0.08 | 15 | 80.0 | 15 | 0.08 | 15 |
| | 10 | 0.05 | 25 | 0.06 | 25 | 0.07 | 30 | 0.08 | 30 |
| | 20 | 0.04 | 35 | 0.05 | 40 | 0.07 | 40 | 0.08 | 40 |
| 1 | 30 | 0.03 | 45 | 0.05 | 45 | 0.06 | 50 | 0.08 | 45 |
| | 40 | 0.03 | 50 | 0.05 | 50 | 0.07 | 50 | 0,08 | 50 |
| | 50 | 0.03 | 55 | 0.05 | 55 | 0.06 | 50 | 0.08 | 50 |
| 10 | 2.0 | 0.09 | 25 | 0.10 | 5.0 | 0.09 | 0 | 0.08 | 0 |
| | 5.0 | 0.06 | 25 | 0.07 | 15 | 0.07 | 20 | 0.07 | 20 |
| | 10 | 0.05 | 30 | 0.06 | 30 | 0.06 | 30 | 0.07 | 35 |
| | 20 | 0.03 | 40 | 0.05 | 40 | 0.06 | 45 | 0.07 | 40 |
| 1 | 30 | 0.03 | 40 | 0.05 | 45 | 0.06 | 47 | 0.07 | 45 |
| - 1 | 40 | 0.03 | 45 | 0.05 | 50 | 0.06 | 50 | 0.07 | 45 |
| l | 50 | 0.03 | 50 | 0.04 | 50 | 0.06 | 50 | 0.07 | 50 |

MRF914

CASE 20-03, STYLE 10 TO-72 (TO-206AF)

HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|------------------|-------------|-------------|
| Collector-Emitter Voltage | VCEO | 12 | Vdc |
| Collector-Base Voltage | VCBO | 20 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Peak | Ic | 40 | mAdc |
| Total Device Dissipation @ T _A = 75°C Derate above 75°C | PD | 200 1.6 | mW mW/°C |
| Storage Temperature | T _{stg} | -65 to +200 | °C |

THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|------------------|-----|------|
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 625 | °C/W |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|------------------|-----|------------|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 1.0 mAdc, Ig = 0) | V(BR)CEO | 12 | _ | - | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.1 mAdc, IE = 0) | V(BR)CBO | 20 | | _ | Vdc |
| Emitter-Base Breakdown Voltage (Ig = 0.1 mAdc, IC = 0) | V(BR)EBO | 3.0 | _ | - | Vdc |
| Collector Cutoff Current (VCB = 15 Vdc, IE = 0) | ICBO | _ | | 50 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 20 mAdc, VCE = 10 Vdc) | hFE | 30 | _ | 200 | _ |
| SMALL SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (tC = 20 mAdc, VCE = 10 Vdc, f = 0.5 GHz) | fτ | _ | 4.5 | - | GHz |
| Collector-Base Capacitance (VCB = 10 Vdc, I _E = 0, f = 1.0 MHz) | C _{cb} | _ | 0.7 | 1.0 | pF |
| FUNCTIONAL TEST | | | | | |
| Noise Figure (I _C = 5.0 mAdc, V _{CE} = 10 Vdc, f = 0.5 GHz) (I _C = 5.0 mAdc, V _{CE} = 10 Vdc, f = 1.0 GHz) | NF | = | 2.0 2.5 | _ | dB |
| Power Gain at Optimum Noise Figure (IC = 5.0 mAdc, VCE = 10 Vdc, f = 0.5 GHz) (IC = 5.0 mAdc, VCE = 10 Vdc, f = 1.0 GHz) | GNF | = | 12 7.0 | | dB |
| Maximum Available Power Gain(1) (IC = 20 mAdc, V _{CE} = 10 Vdc, f = 0.5 GHz) (IC = 20 mAdc, V _{CE} = 10 Vdc, f = 1.0 GHz) | G _{max} | = | 15 10 | _ | dB |

(1) $G_{\text{max}} = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$

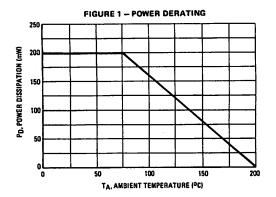


FIGURE 2 - POWER GAIN AND NOISE FIGURE

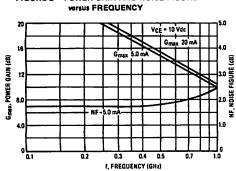


FIGURE 3 – POWER GAIN AND NOISE FIGURE
Versus COLLECTOR CURRENT

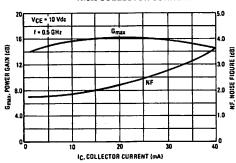


FIGURE 4 - S11 PARAMETERS

| Frequenc | y (MHz) | 10 | 0 | 31 | 00 | 5 | 00 | 7 | 00 | 10 | 00 |
|-----------------|------------------------------|--------------------------------------|---------------------------------|--------------------------------------|---------------------------------|--------------------------------------|------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|
| V _{CE} | IC (mA) | S11 | Lφ | S11 | LΦ | S11 | L ø | S11 | Δ φ | S11 | 4.0 |
| 5.0 | 2.0 5.0 10 20 30 | 0.84 0.65 0.48 0.33 0.27 | -35 -45 -50 -50 | 0.57 0.34 0.32 0.15 0.13 | -80 -85 -85 -75 -70 | 0.42 0.23 0.14 0.10 0.09 | -115 -115 -105 -90 -85 | 0.34 0.18 0.12 0.09 0.09 | -140 -130 -115 -100 -100 | 0.27 0.16 0.09 0.09 0.09 | -166 -150 -120 -101 -101 |
| 10 | 2.0 5.0 10 20 30 | 0.86 0.70 0.55 0.41 0.36 | -30 -40 -45 -45 -45 | 0.59 0.37 0.26 0.21 0.19 | -75 -75 -70 -60 -55 | 0.42 0.24 0.17 0.15 0.14 | -105 -95 -80 -65 -65 | 0.34 0.18 0.14 0.13 0.13 | -130 -110 -90 -75 -75 | 0.25 0.13 0.13 0.14 0.13 | -155 -125 -90 -80 -80 |

FIGURE 5 - S22 PARAMETERS

| Frequenc | y (MHz) | 10 | 0 | 3: | 00 | 5 | 00 | 70 | 00 | 10 | 000 |
|----------------------------|----------------|------|-----|------|------------|------|-----|------|-----|------|-----|
| V _{CE} (Volts) | I _C | S22 | Lø | S22 | Δ φ | S22 | 40 | S22 | 4 | S22 | 40 |
| 5.0 | 2.0 | 0.94 | -15 | 0.77 | -25 | 0.68 | -30 | 0.66 | -35 | 0.64 | -45 |
| | 5.0 | 0.85 | -20 | 0.63 | -30 | 0.57 | -30 | 0.55 | -35 | 0.55 | -45 |
| | 10 | 0.75 | -25 | 0.55 | -25 | 0.51 | -30 | 0.50 | -35 | 0.50 | -40 |
| | 20 | 0.66 | -25 | 0.50 | -25 | 0.47 | -30 | 0.47 | -35 | 0.48 | -40 |
| | 30 | 0.62 | -25 | 0.49 | -25 | 0.46 | -25 | 0.46 | -30 | 0.47 | -40 |
| 10 | 2.0 | 0.95 | -10 | 0.81 | -20 | 0.74 | -30 | 0.72 | -35 | 0.71 | -40 |
| | 5.0 | 0.87 | -15 | 0.69 | -25 | 0.64 | -25 | 0.63 | -30 | 0.63 | -40 |
| | 10 | 0.80 | -20 | 0.63 | -20 | 0.59 | -25 | 0.59 | -30 | 0.60 | -40 |
| | 20 | 0.72 | -20 | 0.59 | -20 | 0.57 | -23 | 0.57 | -30 | 0.58 | -35 |
| | 30 | 0.70 | -20 | 0.59 | -20 | 0.57 | -20 | 0.57 | -30 | 0.58 | -35 |

FIGURE 6 - S21 PARAMETERS

| Frequenc | y (MHz) | 100 | | 300 | | 500 | | 700 | | 1000 | |
|----------------------------|----------|-------|-----|------|------------|------|----|------|----|------|----|
| V _{CE} (Volts) | IC mA | S21 | Lφ | S21 | L Φ | S21 | Lφ | S21 | Lφ | S21 | Lφ |
| 5.0 | 2.0 | 5.99 | 150 | 4.06 | 110 | 2.90 | 90 | 2.27 | 75 | 1.71 | 55 |
| | 5.0 | 11.38 | 135 | 5.91 | 100 | 3.90 | 80 | 2.93 | 70 | 2,17 | 55 |
| | 10 | 15.21 | 125 | 6.78 | 95 | 4.34 | 80 | 3.23 | 70 | 2.38 | 55 |
| | 20 | 17.98 | 115 | 7.27 | 90 | 4.58 | 75 | 3.40 | 65 | 2.50 | 50 |
| | 30 | 18.78 | 110 | 7.37 | 85 | 4.64 | 75 | 3,42 | 65 | 2.50 | 50 |
| 10 | 2.0 | 6.05 | 150 | 4.20 | 115 | 3.04 | 90 | 2.37 | 75 | 1.75 | 55 |
| | 5.0 | 11.46 | 135 | 6.17 | 100 | 4.06 | 85 | 3.08 | 70 | 2.26 | 55 |
| | 10 | 15.45 | 127 | 7.08 | 95 | 4.56 | 80 | 3.41 | 70 | 2.50 | 55 |
| | 20 | 18.35 | 120 | 7.57 | 90 | 4.80 | 75 | 3,58 | 65 | 2.61 | 55 |
| | 30 | 19.12 | 115 | 7.63 | 90 | 4.79 | 75 | 3.56 | 65 | 2.60 | 55 |

FIGURE 7 - S12 PARAMETERS

| Frequenc | y (MHz) | 100 | | 300 | | 500 | | 700 | | 1000 | |
|----------------|------------|------|------------|------|----|------|----|------|------------|------|-----|
| VCE (Volts) | IC (mA) | S12 | ل پ | S12 | Lφ | S12 | Lφ | S12 | L φ | S12 | LΦ |
| 5.0 | 2.0 | 0.04 | 70 | 0.09 | 50 | 0.11 | 50 | 0.12 | 50 | 0.16 | 50 |
| | 5.0 | 0.04 | 70 | 0.07 | 60 | 0.11 | 60 | 0.14 | 60 | 0.19 | 55 |
| | 10 | 0.03 | 70 | 0.07 | 70 | 0.11 | 65 | 0.15 | 65 | 0.20 | 55 |
| | 20 | 0.03 | 75 | 0.07 | 70 | 0.12 | 70 | 0.15 | 65 | 0.21 | 55. |
| | 30 | 0.03 | 75 | 0.07 | 70 | 0.12 | 70 | 0.16 | 65 | 0.21 | 57 |
| 10 | 2.0 | 0.03 | 70 | 0.07 | 55 | 0.09 | 50 | 0,10 | 50 | 0,13 | 55 |
| | 5.0 | 0.03 | 70 | 0.06 | 60 | 0.09 | 65 | 0.12 | 60 | 0.15 | 60 |
| | 10 | 0.03 | 70 | 0.06 | 65 | 0.09 | 65 | 0.12 | 65 | 0.17 | 60 |
| | 20 | 0.03 | 75 | 0.06 | 70 | 0.09 | 70 | 0.13 | 65 | 0.18 | 60 |
| | 30 | 0.03 | 75 | 0.06 | 70 | 0.10 | 70 | 0.13 | 65 | 0.17 | 60 |

MAXIMUM RATINGS

| MAXIMUM KATINGS | | | |
|--|------------------|-------------|-------------|
| Rating | Symbol | Value | Unit |
| Collector-Emitter Voltage | VCEO | 5.0 | Vdc |
| Collector-Base Voltage | VCBO | 10 | Vdc |
| Emitter-Base Voltage | VEBO | 2.0 | Vdc |
| Collector Current — Peak | lc | 5.0 | mAdc |
| Total Device Dissipation @ T _A = 100°C Derate above 100°C | PD | 50 1.0 | mW mW/°C |
| Junction Temperature | TJ | + 150 | - ℃ |
| Storage Temperature | T _{sto} | -65 to +150 | °C |

THERMAL CHARACTERISTICS

| TILLIUME OF MEDICINOTION | | | |
|---|------------------|-----|------|
| Characteristic | Symbol | Max | Unit |
| Thermal Resistance, Junction to Ambient | R _{ØJA} | 500 | °C/W |

MRF931

CASE 317-01, STYLE 2
HIGH FREQUENCY TRANSISTOR
NPN SILICON

Min

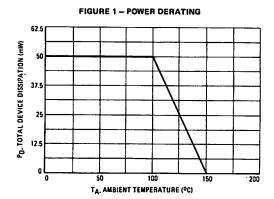
Тур

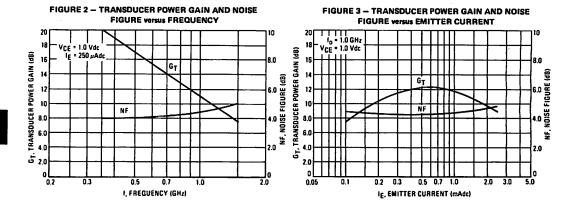
Max

Unit

| ELECTRICAL CHARACTERISTICS (T _A = 25°C unless otherwise noted.) | | | | | |
|--|----------|--|--|--|--|
| Characteristic | Symbol | | | | |
| OFF CHARACTERISTICS | | | | | |
| O. D. A. Cartas, D. antistation Values | Vinniana | | | | |

| OFF CHARACTERISTICS | | | | | |
|--|-----------------|-----|------------|-----|------|
| Collector-Emitter Breakdown Voltage (IC = 0.1 mAdc, Ig = 0) | V(BR)CEO | 5.0 | _ | _ | Vdc |
| Collector-Base Breakdown Voltage (IC = 0.01 mAdc, IE = 0) | V(BR)CBO | 10 | - | _ | Vdc |
| Emitter-Base Breakdown Voltage (I _E = 0.1 mAdc, I _C = 0) | V(BR)EBO | 2.0 | - | 1 | Vdc |
| Collector Cutoff Current (VCB = 5.0 Vdc, IE = 0) | Ісво | 1 | _ | 50 | nAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 0.25 mAdc, VCE = 1.0 Vdc) | hFE | 30 | _ | 150 | 1 |
| SMALL SIGNAL CHARACTERISTICS | | | | | |
| Current-Gain — Bandwidth Product (I _E = 1.0 mAdc, V _{CE} = 1.0 Vdc, f = 1.0 GHz) | fτ | 1 | 3.0 | ı | GHz |
| Collector-Base Capacitance (VCB = 1.0 Vdc, IE = 0, f = 1.0 MHz) | C _{cb} | _ | 0.35 | 0.5 | pF |
| FUNCTIONAL TEST | | | | | |
| Noise Figure (I _E = 0.25 mAdc, V _{CE} = 1.0 Vdc, f = 0.5 GHz) (I _E = 0.25 mAdc, V _{CE} = 1.0 Vdc, f = 1.0 GHz) | NF | | 3.8 4.3 | 1 1 | dB |
| Power Gain at Optimum Noise Figure (IE = 0.25 mAdc, VCE = 1.0 Vdc, f = 0.5 GHz) (IE = 0.25 mAdc, VCE = 1.0 Vdc, f = 1.0 GHz) | GNF | _ | 16 10 | = | dB |
| Transducer Power Gain (IE = 0.5 mAdc, V _{CE} = 1.0 Vdc, f = 0.5 GHz) (IE = 0.5 mAdc, V _{CE} = 1.0 Vdc, f = 1.0 GHz) | GT | | 18 12 | = | dB |





MAXIMUM RATINGS

| Rating | Symbol | MRF966 | MRF967 | Unit |
|--|--------------------------------------|------------------|------------------|-------------|
| Drain-Source Voltage | VDS | 10 | 10 | Vdc |
| Gate-Source Voltage — Reverse | V _{G1S} | -8.0 -8.0 | -8.0 -8.0 | Vdc |
| Gate-Source Voltage — Forward | V _{G1S} V _{G2S} | + 1.0 + 1.0 | + 1.0 + 1.0 | Vdc |
| Drain Current | ID | 60 | 60 | mAdc |
| Total Device Dissipation @ TA = 25°C Derate above 25°C | PD | 350 3.5 | 350 3.5 | mW mW/°C |
| Junction Temperature Range | TJ | - 65 to + 125 | -65 to +125 | °C |
| Storage Channel Temperature Range | T _{stg} | -65 to +125 | - 65 to + 125 | °C |

Mandling and Packaging — MES devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MES devices should be observed.

MRF966

CASE 317-01, STYLE 1

DUAL GATE GaAs FET

N-CHANNEL

MRF967

CASE 358-01, STYLE 2

DUAL GATE GaAs FET

N-CHANNEL

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|---|------------------|-------------------|----------|----------|-------|-------|
| OFF CHARACTERISTICS | | | | | | |
| Drain-Source Breakdown Voltage (VG1S = VG2S = -4.0 Vdc, ID = 100 μA) | | V(BR)DSX | 10 | _ | _ | Vdc |
| Gate 1 Leakage Current (VG1S = -5.0 Vdc, VG2S = VDS = 0) | · | l _{G1SS} | _ | 1 | 10 | μAdc |
| Gate 2 Leakage Current (VG2S = -5.0 Vdc, VG1S = VDS = 0) | | ¹ G2SS | _ | 1 | 10 | μAdc |
| Gete 1 to Source Cutoff Voltage (V _{DS} = 5.0 Vdc, V _{G2S} = 0) | | VG1S(off) | -2.0 | _ | -4.5 | Vdc |
| Gate 2 to Source Cutoff Voltage (V _{DS} = 5.0 Vdc, V _{G1S} = 0) | | VG2S(off) | -2.0 | - | - 4.5 | Vdc |
| ON CHARACTERISTICS | | | | | | |
| Zero-Gate-Voltage Drain (VDS = 5.0 Vdc, VG1S = VG2S = 0) | | IDSS | 30 | 50 | 80 | mAdc |
| SMALL-SIGNAL CHARACTERISTICS | | | | | | |
| Forward Transfer Admittence $(V_{DS} = 5.0 \text{ Vdc}, V_{G2S} = 0, I_D = 10 \text{ mA}, f = 1.0 \text{ kHz})$ | | lyfsl | 14 | 20 | - | mmhos |
| Input Capacitance (Vps = 5.0 Vdc, Vg2s = 0, Ip = 10 mA, f = 1.0 MHz) | | C _{iss} | 1 | 0.45 | _ | pF |
| Reverse Transfer Capacitance (VDS = 5.0 Vdc, VG2S = 0, ID = 10 mA, f = 1.0 MHz) | | C _{rss} | _ | 0.04 | _ | pF |
| FUNCTIONAL CHARACTERISTICS | | | | | | |
| Noise Figure (Vps = 5.0 Vdc, V _{G2S} = 0(1), lps = 10 mA, f = 1.0 GHz) | | NF | _ | 1.2 | 1.5 | dB |
| Common Source Power Gain (VDS = 5.0 Vdc, VG2S = 0(1), IDS = 10 mA, f = 1.0 GHz) | MRF967 MRF966 | G _{ps} | 13 15 | 15 18 | = | dB |
| Intermodulation Distortion (VDS = 5.0 Vdc, IDS = 10 mA, f_1 = 995 MHz, f_2 = 1001 MHz, VG2 = 0, P_{in} = -40 dBm) | | IMD ₃ | _ | - 65 | _ | dB |

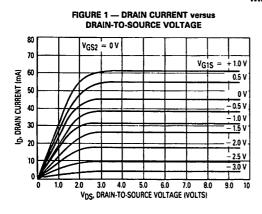
MRF966 • MRF967

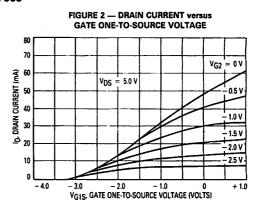
ELECTRICAL CHARACTERISTICS (continued) (TA = 25°C unless otherwise noted.)

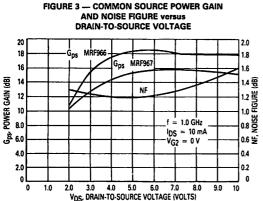
| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|--------|-----|-------|-----|------|
| Linear Power Point(2) (V _{DS} = 5.0 Vdc, I _{DS} = 10 mA, f ₁ = 995 MHz, f ₂ = 1001 MHz, V _{G2} = 0) | PL | _ | + 1.0 | | dBm |
| Output Power at 1 dB Compression Point (VDS = 5.0 Vdc, IDS = 10 mA, f = 1.0 GHz) | Pout | _ | 10 | _ | dBm |

⁽¹⁾ Data taken using a HP11608A 50 Ω test fixture, Microlab slug tuners, HP11590A bias networks and the HP8970A noise figure meter. Note: VG2S = 0. Refer to Figure 16.

TYPICAL CHARACTERISTICS MRF966







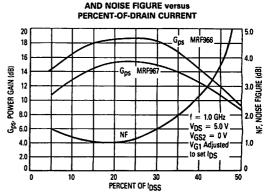
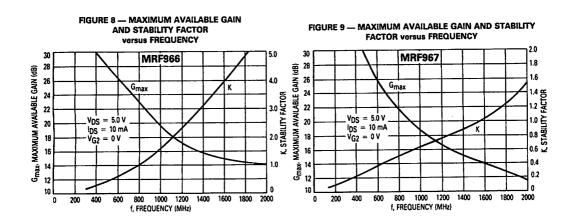


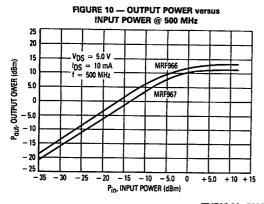
FIGURE 4 — COMMON SOURCE POWER GAIN

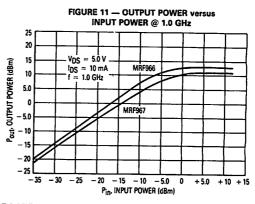
⁽²⁾ The linear power point is the output power level at which either the signal 2f₁ ± f₂ or 2f₂ ± f₁ are 30 dB below f₁ or f₂.

FIGURE 6 — COMMON SOURCE POWER GAIN FIGURE 5 — COMMON SOURCE POWER GAIN AND NOISE FIGURE versus GATE AND NOISE FIGURE versus GATE CONTROL SUPPLY VOLTAGE **ONE-TO-SOURCE VOLTAGE** 10 10 20 MRF966 9.0 18 MRF966 9.0 15 Gps MRF967 Gps 8.0 8.0 10 16 7.0 寶 5 14 POWER GAIN (dB) NF, NOISE FIGURE is = 1.0 GHz 1.0 GHz MRF967 12 VDS = 5.0 V $V_{DS} = 5.0 V$ IDS = 10 mA IDS = 10 mA 10 VG2 = 0 V - 10 8.0 <u>بۇ</u> 6.0 - 15 NF - 20 2.0 2.0 4.0 NF 1.0 1.0 - 25 0 - 2.0 +1.0- 4.0 -3.0-4.0 -3.0-2.0-1.0+1.0VG2S, GATE CONTROL SUPPLY VOLTAGE (VOLTS) VGIS. GATE ONE-TO-SOURCE VOLTAGE (VOLTS)

FIGURE 7 — COMMON SOURCE POWER GAIN AND NOISE FIGURE versus FREQUENCY 20 5.0 18 4.0 Gps MRF967 æ POWER GAIN (dB) 14 NOISE FIGURE (c 12 $V_{DS} = 5.0 V$ 10 IDS = 10 mA 8.0 VG2 = 0 V ģ 按 NF 4.0 1.0 2.0 0 2000 0 200 400 600 800 1000 1200 1400 1600 1800 f, FREQUENCY (MHz)

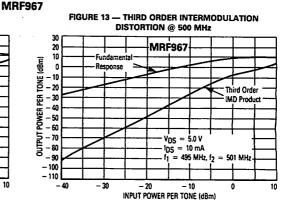


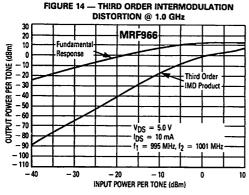


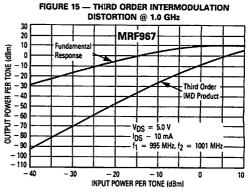


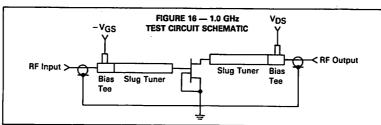
TYPICAL CHARACTERISTICS

FIGURE 12 — THIRD ORDER INTERMODULATION DISTORTION @ 500 MHz 20 **MRF966** 10 Fundamental (dBm) 0 Response - 10 PER TONE - 20 Third Order **- 30** IMD Product - 40 V_{DS} = 5.0 V IDS = 10 mA f1 = 495 MHz, f2 = 501 MHz -- 90 - 100 - 110 -40 - 30 - 10 INPUT POWER PER TONE (dBm)

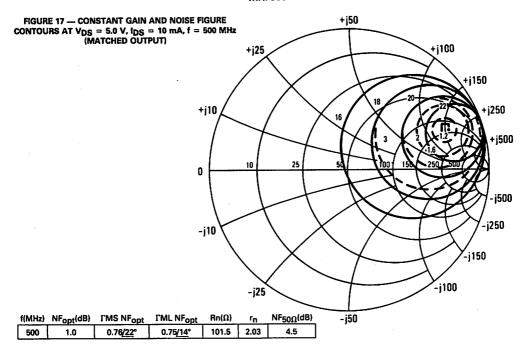


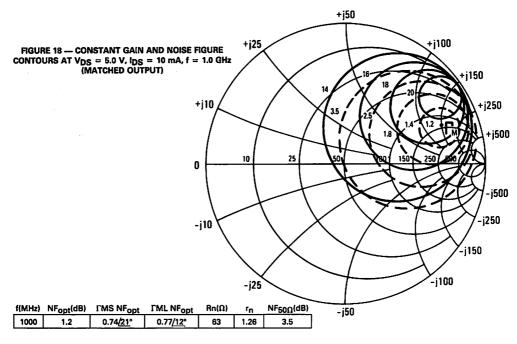






MRF966

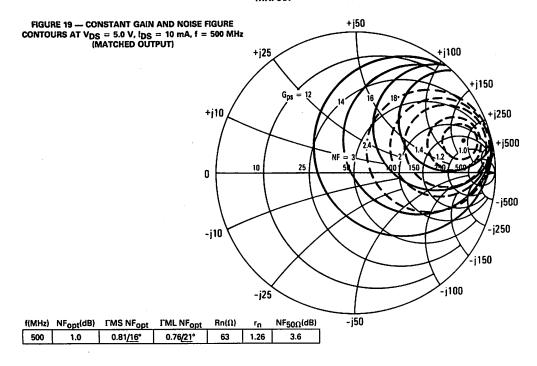


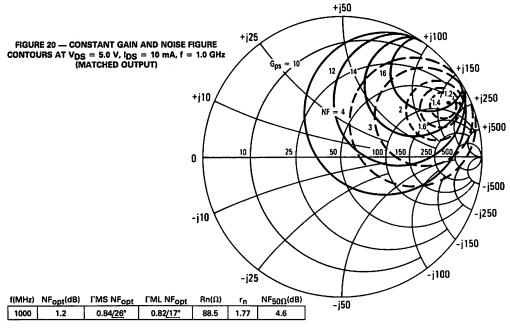


MRF966 COMMON-SOURCE S-PARAMETERS

| • | | | | 11 | S ₂ | | Sı | | S ₂ | |
|----------------|------|--------|-----------------|-------|-----------------|-----|-----------------|----------|-----------------|----------|
| VDS (Volts) | (mA) | (MHz) | S ₁₁ | | S ₂₁ | | S ₁₂ | <u>∠</u> | S ₂₂ | ∠φ |
| 3.0 | 5.0 | 200 | 0.99 | -4.0 | 1.10 | 171 | 0.002 | 94 | 0.96 | -3.0 |
| | ": | 500 | 0.96 | - 12 | 1.07 | 155 | 0.004 | 79 | 0.95 | -8.0 |
| | l . | 1000 | 0.92 | -24 | 1.06 | 134 | 0.008 | 71 | 0.93 | - 17 |
| | 1 | 1500 | 0.84 | -38 | 1.00 | 112 | 0.008 | 70 | 0.90 | - 26 |
| | | 2000 | 0.71 | -49 | 0.96 | 90 | 0.006 | 100 | 0.86 | -34 |
| | 10 | 200 | 0.99 | - 5.0 | 1.31 | 171 | 0.002 | 82 | 0.95 | -3.0 |
| | | 500 | 0.96 | - 13 | 1.28 | 155 | 0.005 | 78 | 0.94 | -8.0 |
| | | 1000 | 0.90 | - 26 | 1.25 | 134 | 0.008 | 73 | 0.91 | -17 |
| | | 1500 | 0.81 | -40 | 1.19 | 112 | 0.009 | 72 | 0.88 | -27 |
| • | | - 2000 | 0.67 | -51 | 1.08 | 90 | 0.008 | 100 | 0.84 | -35 |
| | 15 | 200 | 0.99 | - 5.0 | 1.34 | 170 | 0.002 | 92 | 0.93 | - 3.0 |
| | | 500 | 0.96 | - 14 | 1.30 | 155 | 0.005 | 78 | 0.93 | -8.0 |
| | | 1000 | 0.90 | - 27 | 1.29 | 133 | 0.009 | 73 | 0.91 | - 17 |
| | | 1500 | 0.79 | -42 | 1.23 | 111 | 0.009 | 74 | 0.87 | -26 |
| | | 2000 | 0.65 | - 53 | 1.12 | 88 | 0.009 | 98 | 0.83 | - 34 |
| | 20 | 200 | 0.99 | - 5.0 | 1.24 | 170 | 0.002 | 95 | 0.91 | -3.0 |
| | | 500 | 0.96 | 15 | 1.21 | 154 | 0.006 | 80 | 0.90 | -8.0 |
| | | 1000 | 0.89 | ~ 29 | 1.20 | 131 | 0.010 | 74 | 0.88 | - 17 |
| | | 1500 | 0.79 | - 45 | 1.17 | 108 | 0.011 | 74 | 0.85 | - 26 |
| | | 2000 | 0.64 | | 1.08 | 84 | 0.012 | 94 | 0.83 | - 33 |
| 5.0 | 5.0 | 200 | 0.99 | - 5.0 | 1.33 | 170 | 0.001 | 84 | 0.97 | - 3.0 |
| | | 500 | 0.98 | - 13 | 1.29 | 156 | 0.004 | 70 | 0.97 | - 9.0 |
| | | 1000 | 0.90 | 27 | 1.25 | 132 | 0.006 | 78. | 0.95 | - 17 |
| | | 1500 | 0.81 | - 40 | 1.19 | 112 | 0.005 | 73 | 0.91 | - 25 |
| | | 2000 | 0.68 | -51 | 1.00 | 94 | 0.006 | 115 | 0.88 | - 35 |
| | 10 | 200 | 0.99 | - 5.0 | 1.66 | 170 | 0.001 | 75 | 0.97 | -3.0 |
| | | 500 | 0.97 | 14 | 1.63 | 156 | 0.004 | 76 | 0.96 | -9.0 |
| | | 1000 | 0.89 | - 28 | 1.56 | 132 | 0.006 | 79 | 0.94 | <u> </u> |
| | | 1500 | 0.78 | -41 | 1.47 | 112 | 0.005 | 80 | 0.90 | - 25 |
| | | 2000 | 0.65 | - 52 | 1.23 | 94 | 0.007 | 121 | 0.87 | - 35 |
| | 15 | 200 | 0.99 | - 5.0 | 1.84 | 170 | 0.001 | 78 | 0.96 | -3.0 |
| | | 500 | 0.97 | - 14 | 1.80 | 155 | 0.004 | 72 | 0.95 | -8.0 |
| | | 100 | 0.89 | - 29 | 1.71 | 131 | 0.006 | 79 | 0.94 | - 17 |
| | | 1500 | 0.77 | -42 | 1.61 | 110 | 0.005 | 83 | 0.90 | -25 |
| | | 2000 | 0.63 | - 52 | 1.34 | 93 | 0.007 | 119 | 0.87 | -34 |
| | 20 | 200 | 0.99 | - 5.0 | 1.89 | 170 | 0.001 | 71 | 0.96 | -3.0 |
| | | 500 | 0.97 | - 15 | 1.84 | 155 | 0.004 | 78 | 0.95 | - 9.0 |
| | | 1000 | 0.87 | -30 | 1.75 | 130 | 0.006 | 80 | 0.93 | -17 |
| | | 1500 | 0.75 | -43 | 1.64 | 109 | 0.006 | 84 | 0.90 | -24 |
| | | 2000 | 0.61 | -54 | 1.37 | 91 | 0.008 | 123 | 0.87 | - 34 |

MRF967





MRF967 COMMON-SOURCE S-PARAMETERS

| V | | , | s | 11 | S ₂ | | Sız | , | S | |
|-----------------|-------------------------|--------|-----------------|------|-----------------|-----|-----------------|----|-----------------|------|
| V _{DS} | ⁽ DS (mA) | (MHz) | S ₁₁ | | S ₂₁ | | S ₁₂ | | S ₂₂ | |
| 3.0 | 5.0 | 200 | 0.99 | -5 | 1.19 | 170 | 0.005 | 77 | 0.96 | -4 |
| | | 500 | 0.97 | - 14 | 1.16 | 155 | 0.016 | 73 | 0.94 | -11 |
| | | 1000 | 0.92 | - 27 | 1.11 | 131 | 0.030 | 65 | 0.93 | -21 |
| | | 1500 | 0.86 | - 40 | 1.03 | 111 | 0.040 | 54 | 0.87 | -31 |
| | | 2000 | 0.78 | - 52 | 0.96 | 91 | 0.048 | 45 | 0.83 | -43 |
| | 10 | 200 | 0.99 | -5 | 1.47 | 170 | 0.006 | 81 | 0.95 | -4 |
| | | 500 | 0.97 | - 15 | 1.43 | 155 | 0.016 | 73 | 0.93 | -11 |
| | | 1000 | 0.91 | - 29 | 1.39 | 131 | 0.031 | 65 | 0.92 | -21 |
| | | 1500 | 0.84 | - 43 | 1.29 | 111 | 0.040 | 54 | 0.86 | -31 |
| | | 2000 · | 0.75 | - 56 | 1.19 | 90 | 0.047 | 45 | 0.81 | - 44 |
| | 15 | 200 | 1.00 | -6 | 1.50 | 170 | 0.006 | 82 | 0.93 | -4 |
| | | 500 | 0.97 | - 16 | 1.46 | 155 | 0.016 | 74 | 0.91 | - 11 |
| | ' | 1000 | 0.89 | -31 | 1.42 | 131 | 0.031 | 64 | 0.90 | -21 |
| | | 1500 | 0.83 | - 46 | 1.33 | 110 | 0.040 | 53 | 0.84 | -31 |
| | | 2000 | 0.73 | - 59 | 1.24 | 89 | 0.048 | 45 | 0.79 | -43 |
| | 20 | 200 | 1.00 | -6 | 1.33 | 170 | 0.007 | 78 | 0.90 | -3 |
| | | 500 | 0.97 | - 17 | 1.30 | 154 | 0.017 | 73 | 0.88 | - 10 |
| | | 1000 | 0.89 | - 33 | 1.27 | 129 | 0.033 | 64 | 0.88 | - 21 |
| | | 1500 | 0.82 | - 49 | 1.21 | 108 | 0.043 | 53 | 0.82 | - 30 |
| | | 2000 | 0.73 | - 63 | 1.14 | 86 | 0.050 | 44 | 0.78 | -42 |
| 5.0 | 5.0 | 200 | 0.99 | -5 | 1.17 | 170 | 0.006 | 84 | 0.97 | -3 |
| | | 500 | 0.97 | - 14 | 1.16 | 155 | 0.014 | 76 | 0.97 | -9 |
| | | 1000 | 0.93 | - 27 | 1.11 | 131 | 0.027 | 65 | 0.94 | - 18 |
| | ĺ | 1500 | 0.87 | - 28 | 1.07 | 110 | 0.039 | 57 | 0.93 | - 28 |
| | | 2000 | 0.79 | - 53 | 0.97 | 91 | 0.045 | 50 | 0.88 | -37 |
| | 10 | 200 | 0.99 | -5 | 1.47 | 170 | 0.006 | 84 | 0.97 | -3 |
| | | 500 | 0.97 | - 15 | 1.43 | 156 | 0.014 | 76 | 0.96 | -9 |
| | | 1000 | 0.92 | - 29 | 1.35 | 132 | 0.027 | 65 | 0.93 | - 18 |
| | 1 | 1500 | 0.85 | - 44 | 1.32 | 111 | 0.038 | 57 | 0.90 | - 29 |
| | | 2000 | 0.77 | - 56 | 1.19 | 91 | 0.044 | 49 | 0.86 | - 37 |
| | 15 | 200 | 1.00 | -6 | 1.53 | 170 | 0.006 | 85 | 0.96 | -3 |
| | | 500 | 0.98 | - 15 | 1.48 | 156 | 0.014 | 77 | 0.95 | -9 |
| | | 1000 | 0.91 | - 29 | 1.41 | 131 | 0.027 | 64 | 0.93 | - 18 |
| | | 1500 | 0.85 | - 46 | 1.37 | 110 | 0.038 | 57 | 0.90 | -28 |
| | | 2000 | 0.75 | - 58 | 1.24 | 90 | 0.043 | 49 | 0.86 | -36 |
| | 20 | 200 | 1.00 | -6 | 1.32 | 170 | 0.006 | 85 | 0.95 | -3 |
| | | 500 | 0.98 | - 16 | 1.29 | 155 | 0.015 | 76 | 0.95 | -8 |
| | | 1000 | 0.91 | - 32 | 1.23 | 129 | 0.027 | 64 | 0.92 | - 17 |
| | } . | 1500 | 0.88 | - 49 | 1.21 | 107 | 0.038 | 55 | 0.90 | -27 |
| | | 2000 | 0.75 | - 62 | 1.11 | 87 | 0.043 | 48 | 0.86 | - 36 |

MRF8003

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

RF AMPLIFIER TRANSISTOR

NPN SILICON

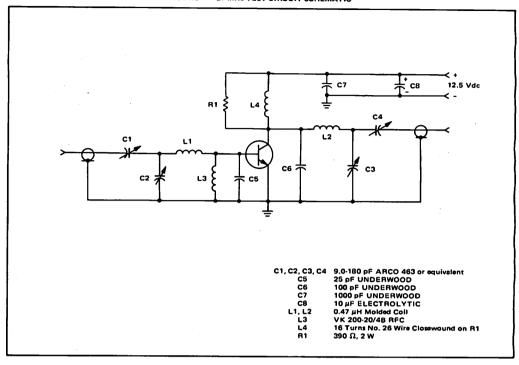
MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|---------------|
| Collector-Emitter Voltage | VCEO | 30 | Vdc |
| Collector-Base Voltage | V _{CBO} | 50 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | 1 _C | 0.5 | Adc |
| Total Device Dissipation @ T _A = 25°C Derate above 25°C | PD | 1.0 5.7 | Watt mW/°C |
| Storage Temperature | T _{sto} | -65 to +200 | ℃ |

ELECTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|------------------|-----|-----|-----|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage { C = 10 mAdc, lg = 0} | V(BR)CEO | 30 | _ | _ | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 0.1 mAdc, VBE = 0) | V(BR)CES | 50 | - | | Vdc |
| mitter-Base Breakdown Voltage (IE = 0.5 mAdc, IC = 0) | V(BR)EBO | 3.0 | - | _ | Vdc |
| Collector Cutoff Current (VCB = 12 Vdc, IE = 0) | ICBO | _ | - | 0.1 | mAdc |
| ON CHARACTERISTICS | | | | | , |
| DC Current Gain (IC = 100 mAdc, VCE = 10 Vdc) | hFE | 20 | _ | _ | _ |
| SMALL-SIGNAL CHARACTERISTICS | | | | | |
| Output Capacitance (VCB = 12.5 Vdc, I _E = 0, f = 1.0 MHz) | C _{obo} | _ | | 15 | pF |
| FUNCTIONAL TEST (FIGURE 1) | | | | | |
| Common-Emitter Amplifier Power Gain (VCC = 12.5 Vdc, Pout = 0.5 W, f = 27 MHz) | GPE | 10 | _ | _ | dB |
| Collector Efficiency (VCC = 12.5 Vdc, Pout = 0.5 W, f = 27 MHz) | η | | 50 | | % |

FIGURE 1 - 27 MHz TEST CIRCUIT SCHEMATIC



MRF8004

CASE 79-02, STYLE 1 TO-39 (TO-205AD)

RF AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|------------------|-------------|----------------|
| Collector-Emitter Voltage | VCEO | 30 | Vdc |
| Collector-Base Voltage | VCBO | 60 | Vdc |
| Emitter-Base Voltage | VEBO | 3.0 | Vdc |
| Collector Current — Continuous | lc | 1.0 | Adc |
| Total Device Dissipation @ T _C = 25°C(1) Derate above 25°C | PD | 5.0 28.6 | Watts mW/°C |
| Storage Temperature | T _{stg} | -65 to +200 | °C |

⁽¹⁾ This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

FI FCTRICAL CHARACTERISTICS (TA = 25°C unless otherwise noted.)

| Characteristic | Symbol | Min | Тур | Max | Unit |
|--|------------------|------|----------|------|------|
| OFF CHARACTERISTICS | | | | | |
| Collector-Emitter Breakdown Voltage (IC = 50 mAdc, Ig = 0) | V(BR)CEO | 30 | _ | _ | Vdc |
| Collector-Emitter Breakdown Voltage (IC = 200 mAdc, VBE = 0) | V(BR)CES | 60 | <u> </u> | _ | Vdc |
| Emitter-Base Breakdown Voltage (IE = 1.0 mAdc, IC = 0) | V(BR)EBO | 3.0 | _ | _ | Vdc |
| Collector Cutoff Current (V _{CB} = 15 Vdc, I _E = 0) | ІСВО | - | _ | 0.01 | mAdc |
| ON CHARACTERISTICS | | | | | |
| DC Current Gain (IC = 400 mAdc, VCE = 2.0 Vdc) | pte | 10 | | | |
| SMALL SIGNAL CHARACTERISTICS | | | | | |
| Output Capacitance (VCB = 12.5 Vdc, IE = 0, f = 1.0 MHz) | C _{obo} | _ | 35 | 70 | pF |
| FUNCTIONAL TEST | | | | | |
| Common-Emitter Amplifier Power Gain (See Figure 1) (Pout = 3.5 W, V _{CC} = 12.5 Vdc, f = 27 MHz) | GPE | 10 | _ | _ | dB |
| Collector Efficiency(2) (See Figure 1) (Pout = 3.5 W, VCC = 12.5 Vdc, f = 27 MHz) | η | 62.5 | 70 | _ | % |
| Percentage Up-Modulation(1) (See Figure 1) (f = 27 MHz) | _ | _ | 85 | _ | % |
| Parallel Equivalent Input Resistance (Pout = 3.5 W, V _{CC} = 12.5 Vdc, f = 27 MHz) | R _{in} | _ | 21 | | Ohms |
| Parallel Equivalent Input Capacitance (Pout = 3.5 W, VCC = 12.5 Vdc, f = 27 MHz) | C _{in} | _ | 900 | _ | pF |
| Parallel Equivalent Output Capacitance (Pout = 3.5 W, VCC = 12.5 Vdc, f = 27 MHz) | C _{out} | _ | 200 | _ | pF |

(1) Percentage Up-Modulation is measured in the test circuit (Figure 1) by setting the Carrier Power (Pc) to 3.5 Watts with VCC = 12.5 Vdc (1) Percentage Up-Modulation is measured in the test circuit (Figure 1) by setting the Carrier Power (P_c) to 3.5 Watts with $V_{CC} = 12.5 \text{ Volume}$ and noting the power input. Then the Peak Envelope Power (PEP) is noted after doubling the original power input to simulate driver modulation (at a 25% duty cycle for thermal considerations) and raising the V_{CC} to 25 Vdc (to simulate the modulating voltage). Percentage Up-Modulation is then determined by the relation:

Percentage Up-Modulation = $\left[\left(\frac{PEP}{P_C}\right)^{\frac{1}{2}}-1\right] \cdot 100$

Percentage Up-Modulation =
$$\left[\left(\frac{PEP}{Pc} \right)^{72} - 1 \right] \cdot 100$$

(2)
$$\eta = \frac{R_F P_{out}}{(Voc)(Io)} \cdot 100$$

FIGURE 1 - 27 MHz TEST CIRCUIT

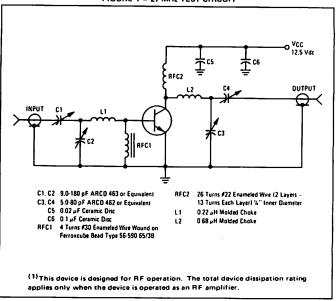


FIGURE 2 – CIRCUIT TUNED AT 25 V, 25% DUTY CYCLE,
Pout = 15 W PEAK

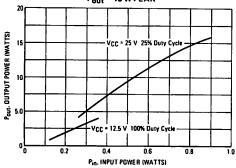


FIGURE 3 – CIRCUIT TUNED AT 12.5 V.Pout = 4 W

20

15

VCC - 25 V 25% Duty Cycle

VCC - 12.5 V 100% Outy Cycle

0 03 0.5 0.9 1.2 1.5

Pin. INPUT POWER (WATTS)

MAXIMUM RATINGS

| WATER TEATHER | <u> </u> | | Value | | |
|---------------------------|------------------|-------|-----------|--------|------|
| Rating | Symbol | MWA11 | 0 MWA120 | MWA130 | Unit |
| RF Input Power | Pin | | 100 | | |
| DC Supply Current | ۵l | 25 | 55 | 100 | mA |
| Maximum Case Temperature | TC | 125 | | | °C |
| Storage Temperature Range | T _{stq} | | -65 to +2 | 00 | ဇင |

OPERATING CONDITIONS

| Device Voltage | VD | 2.9 | 5.0 | 5.5 | Vdc |
|----------------------|----|------|------|-----|------|
| Device Current | ΙD | 10 | 25 | 60 | mAdc |
| Decoupling Impedance | Zn | 1000 | 1000 | 330 | Ω |

MWA110 MWA120 MWA130

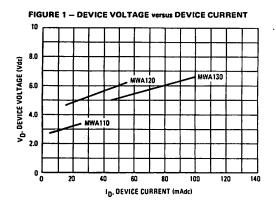
CASE 31A-01, STYLE 2

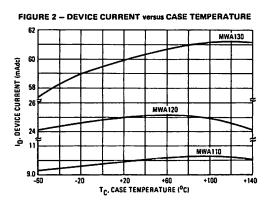
GENERAL PURPOSE HYBRID

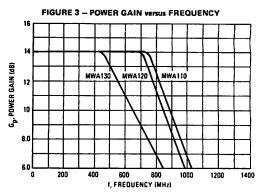
AMPLIFIERS

FLECTRICAL CHARACTERISTICS (TC = -25 to $+125^{\circ}$ C, 50 Ω system and specified operating conditions.)

| Characteristic | | Symbol | Min | Тур | Max | Unit |
|----------------------------------|--|-----------------|--------------|------------------------|--------------|------|
| Frequency Range | | BW | 0.1 | _ | 400 | MHz |
| Power Gain | | Gp | 13 | 14 | - | ₫B |
| Response Flatness | | F | _ | 0 | ±1.0 | dB |
| Input VSWR | MWA110/120 MWA130 | | = | | 2.5:1 3:1 | 1 1 |
| Output VSWR | MWA110/120/130 | | - | _ | 2.5:1 | - |
| Output @ 1.0 dB Gain Compression | MWA110 MWA120 MWA130 | | _ | - 2.5 + 8.2 + 18 | <u> </u> | dBm |
| Noise Figure | MWA110 MWA120 MWA130 | NF | = | 4.0 5.5 7.0 | = | ₫B |
| Reverse Isolation | MWA110 MWA120 MWA130 | PRI | - - | 18.8 19.2 16.8 | | dB |
| Harmonic Output | MWA110 (P _{out} = -9.0 dBm) MWA120 (P _{out} = 0 dBm) MWA130 (P _{out} = +10 dBm) | d _{SO} | = | - 24 - 34 - 35 | _ _ _ | dB |







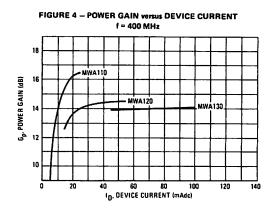


FIGURE 5 — POWER GAIN versus CASE TEMPERATURE f = 100 MHz

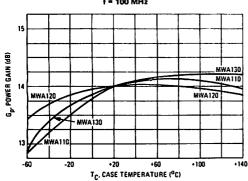


FIGURE 6 – POWER GAIN versus CASE TEMPERATURE f = 400 MHz

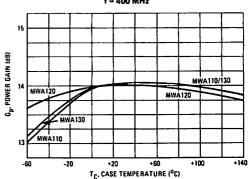


FIGURE 7 - VSWR versus FREQUENCY

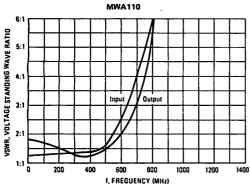


FIGURE 8 - VSWR versus FREQUENCY

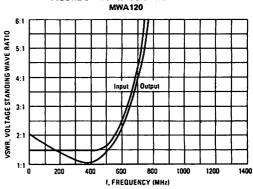


FIGURE 9 - VSWR versus FREQUENCY

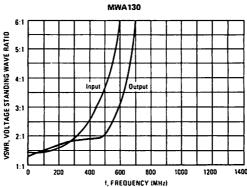


FIGURE 10 – INPUT AND OUTPUT IMPEDANCE versus FREQUENCY MWA110

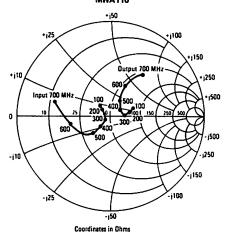


FIGURE 11 – INPUT AND OUTPUT IMPEDANCE versus FREQUENCY

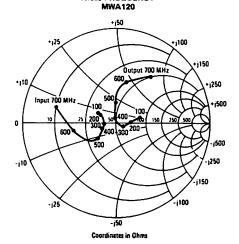


FIGURE 12 – INPUT AND OUTPUT IMPEDANCE

VETSUS FREQUENCY

MWA130

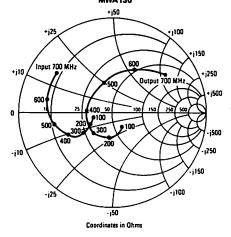


FIGURE 13 - 1.0 dB GAIN COMPRESSION WISES FREQUENCY

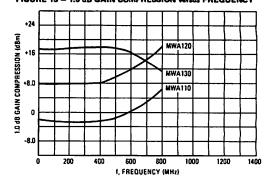


FIGURE 14 - 1.0 dB GAIN COMPRESSION versus DEVICE CURRENT

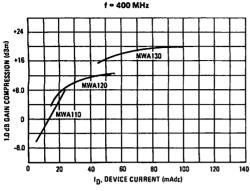


FIGURE 15 - 1.0 dB GAIN COMPRESSION versus CASE TEMPERATURE

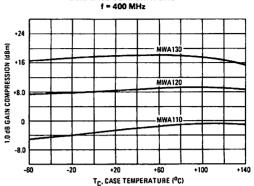
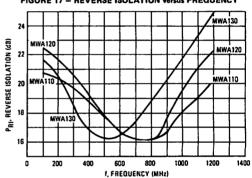
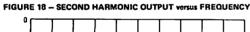


FIGURE 16 - NOISE FIGURE versus FREQUENCY 10 8.0 MWA130 (gp) NF, NOISE FIGURE 6.0 MWA120 MWA110 2.0 0 r 200 400 600 800 1000 I, FREQUENCY (MHz)

FIGURE 17 - REVERSE ISOLATION Versus FREQUENCY





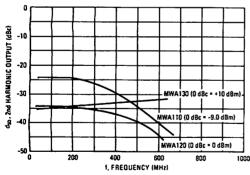


FIGURE 19 - SECOND AND THIRD ORDER INTERCEPT

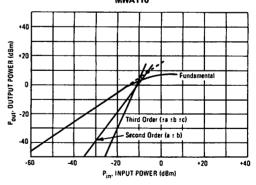


FIGURE 20 – SECOND AND THIRD ORDER INTERCEPT MWA120

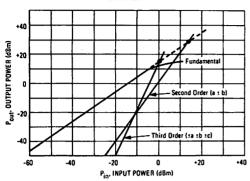


FIGURE 21 - SECOND AND THIRD ORDER INTERCEPT MWA130

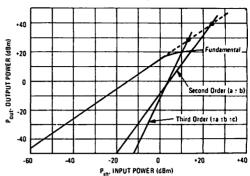


FIGURE 22 – INTERMODULATION DISTORTION

versus POWER OUTPUT

MWA110

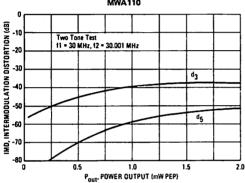


FIGURE 23 — INTERMODULATION DISTORTION VEISUS POWER OUTPUT

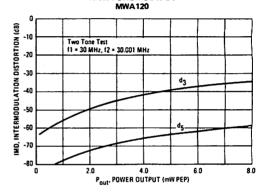


FIGURE 24 — INTERMODULATION DISTORTION
VOISUS POWER OUTPUT
MWA130

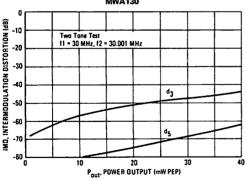
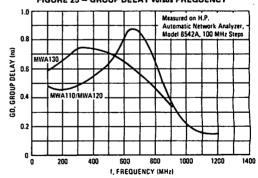


FIGURE 25 - GROUP DELAY versus FREQUENCY



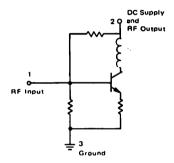
MWA SERIES HYBRID AMPLIFIER APPLICATIONS INFORMATION

The MWA series hybrid amplifiers are designed for wideband general purpose applications in 50 Ω systems. Fully cascadable for any gain combination, operable at voltages as low as 3 Vdc, and external control of the low frequency corner make the MWA amplifiers extremely versatile gain blocks.

Basic Circuit Configuration

Figure 26 shows the basic internal circuit. It is important to note that the specified operating conditions of voltage, current, and external decoupling impedance must be applied to the units in order to achieve the published electrical characteristics.

FIGURE 26 - INTERNAL CIRCUIT



Amplifier Application

The circuit schematic for a simple amplifier design is shown in Figure 27. External to the MWA hybrid amplifier the only components required are:

Decoupling elements – Bypass Capacitor
Decoupling Impedance
(resistor/inductor)

DC Blocking Capacitors at the RF input and output.

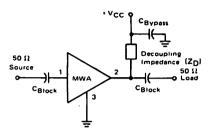
External Decoupling Impedance

In all cases the external bias (decoupling elements) must present an impedance which is large compared to the 50 Ω load impedance to minimize RF gain reduction. The loss in gain due to the decoupling impedance is given by the equation:

$$Loss = 20 Log \frac{Z_D}{Z_D + 25} dB$$

where $Z_D =$ decoupling impedance in ohms. For example, if $Z_D = 1 \text{ k}\Omega$, Loss = 0.214 dB.

FIGURE 27 - AMPLIFIER SCHEMATIC DIAGRAM



Supply Voltage

The value of the external decoupling resistive impedance (RD) determines the supply voltage (+VCC) and is determined by the following equation:

where ID and VD are the device current and voltage stated in the data sheet. For example, for MWA1.10,

and, if RD = 330 Ω , then

More commonly V_{CC} is predetermined and R_D may be calculated from:

$$R_D = \frac{V_{CC} - V_D}{I_D}$$

If an RF choke is used for decoupling, then the supply voltage (V_{CC}) required is equal to the device voltage (V_D).

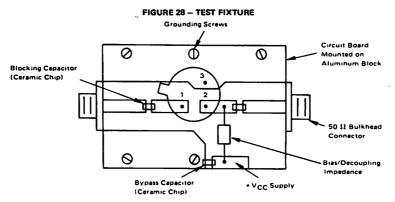
Low Frequency Response

The value of the blocking capacitors determines the low frequency response of the amplifier. The following expression is used to determine the blocking capacitor value to yield a desired 3 dB low frequency corner (fLFC).

$$C_{Block}(Farads) = \frac{1}{100 \pi f_{LFC}(Hz)}$$

Bypass Capacitor

The reactive impedance of the bypass capacitor should be small compared to the impedance of the decoupling element at the lowest frequency of operation.



Note: The circuitry indicated is on the underside of the printed circuit board with sockets for the amplifier pins. The case of the amplifier should contact the printed circuit board top surface to ensure effective RF grounding.

Text Fixture

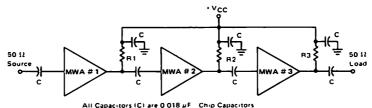
The 50 Ω input/output impedance levels of the MWA hybrids are most easily preserved on a circuit board by using 50 Ω microstrip transmission lines. Figure 28 is an example of a circuit board layout which utilizes microstrip transmission lines in conjunction with other sound RF construction techniques.

The characteristic impedance and corresponding line width of the microstrip are a function of the circuit board dielectric constant and thickness. The table lists appropriate line widths for 50 Ω microstrip lines on commonly used circuit board materials.

| MATERIAL TYPE | DIELECTRIC CONSTANT | DIELECTRIC THICKNESS INCHES | LINE WIDTH INCHES |
|-----------------------|------------------------|-----------------------------------|-------------------------|
| Teflon- Fiberglass | 2.5 | 0.03125 0.0625 | 0.090 0.180 |
| Fiberglass Epoxy | 5.0 | 0.0625 | 0.100 |

As in all good RF circuit designs, care should be taken to minimize parasitic lead inductances and to provide adequate grounding.

FIGURE 29 - TYPICAL CASCADE



Cascading

The inherent stability of the MWA hybrid modules makes possible the cascading of two or more units with no oscillatory problems. Figure 29 shows a typical 3 hybrid cascade with measured data for 400 MHz and 1000 MHz hybrids.

| | Cascade 1 | Cascade 2 |
|------------------------|-----------------|------------------|
| Frequency Range | 0.25 to 400 MHz | 0.25 to 1000 MHz |
| Gain | 43.5 dB | 20.5 d8 |
| Gain Flatness | ± 1.0 dB | ± 0.75 dB |
| Input VSWR | 2.0:1 | 2.4:1 |
| Output VSWR | 1.2:1 | 2.1:1 |
| V _{CC} Supply | 12 Vdc | 33 Vdc |
| 1 Supply | 44 mAdc | 150 mAdc |
| MWA #1 | MWA110 | MWA320 |
| MWA #2 | MWA110 | MWA330 |
| MWA #3 | MWA120 | MWA330 |
| R1 | 1000 Ω | 1000 Ω |
| R2 | 1000 Ω | 500 Ω |
| R3 | 300 Ω | 500 Ω |

MAXIMUM RATINGS

| WAXIIION IIA IIGO | | | | | |
|---------------------------|------------------|--------|-----------|--------|------|
| | | | | | |
| Rating | Symbol | MWA210 | MWA220 | MWA230 | Unit |
| RF Input Power | Pin | | 100 | | mW |
| DC Supply Current | l _D | 25 | 55 | 100 | mA |
| Maximum Case Temperature | ТС | 125 | | | °C |
| Storage Temperature Range | T _{sta} | | -65 to +2 | 00 | °C |

OPERATING CONDITIONS

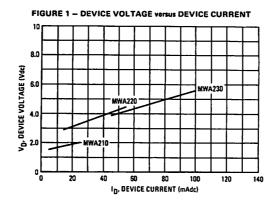
| Device Voltage | V _D | 1.75 | 3.2 | 4.4 | Vdc |
|----------------------|----------------|------|------|-----|------|
| Device Current | ΙD | 10 | 25 | 60 | mAdc |
| Decoupling Impedance | Zn | 1000 | 1000 | 330 | Ω |

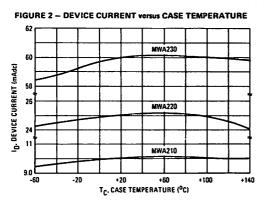
MWA210 MWA220 MWA230

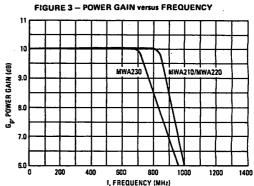
CASE 31A-01, STYLE 2
GENERAL PURPOSE HYBRID
AMPLIFIERS

ELECTRICAL CHARACTERISTICS (TC = -25 to +100 °C, $50~\Omega$ system and specified operating conditions.)

| Charact | teristic | Symbol | Min | Тур | Max | Unit |
|----------------------------------|--|-----------------|-------------|---------------------------|--------------|------|
| Frequency Range | | BW | 0.1 | _ | 600 | MHz |
| Power Gain | | Gp | 9.0 | 10 | _ | dB |
| Response Flatness | | F | _ | 0 | ± 1.0 | dB |
| Input VSWR | MWA210/220 MWA230 | _ | - - | 11 | 2.5:1 3:1 | _ |
| Output VSWR | MWA210/220/230 | | _ | _ | 2.5:1 | |
| Output @ 1.0 dB Gain Compression | MWA210 MWA220 MWA230 | | _ _ _ | + 1.5 + 10.5 + 18.5 | 1 1 1 | dBm |
| Noise Figure | MWA210 MWA220 MWA230 | NF | _ | 6.0 6.5 7.5 | | dB |
| Reverse Isolation | MWA210 MWA220 MWA230 | PRI | _ _ _ | 13.5 14.5 12.9 | - | ₫B |
| Harmonic Output | MWA210 (P _{out} = -9.0 dBm) MWA220 (P _{out} = 0 dBm) MWA230 (P _{out} = +10 dBm) | d _{SO} | = | - 29 - 36 - 36 | = | dB |







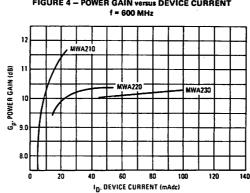


FIGURE 4 - POWER GAIN versus DEVICE CURRENT

FIGURE 5 - POWER GAIN versus CASE TEMPERATURE

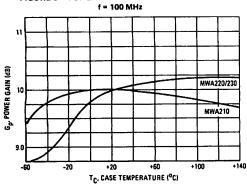


FIGURE 6 - POWER GAIN versus CASE TEMPERATURE f = 600 MHz

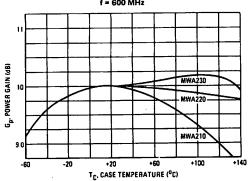


FIGURE 7 - VSWR versus FREQUENCY

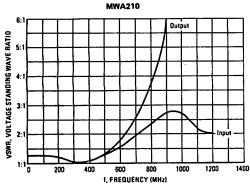


FIGURE 8 - VSWR versus FREQUENCY

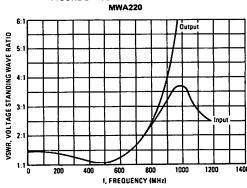


FIGURE 9 - VSWR versus FREQUENCY MWA230

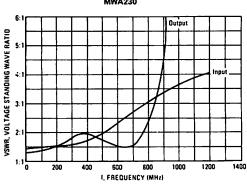


FIGURE 10 – INPUT AND OUTPUT IMPEDANCE versus FREQUENCY MWA210

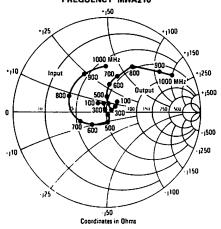


FIGURE 11 - INPUT AND OUTPUT IMPEDANCE

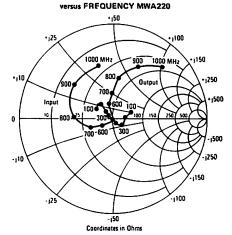


FIGURE 12 – INPUT AND OUTPUT IMPEDANCE versus FREQUENCY MWA230

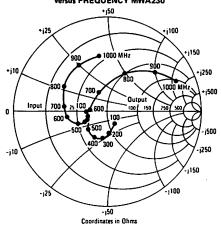
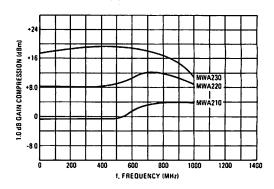
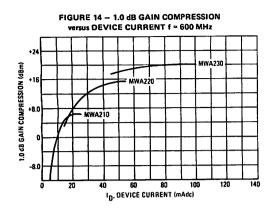
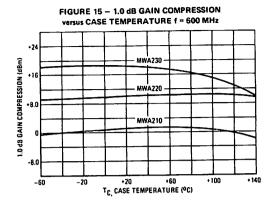
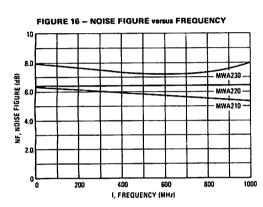


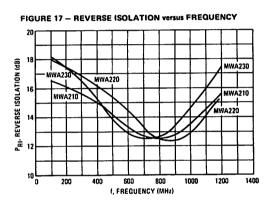
FIGURE 13 - 1.0 dB GAIN COMPRESSION versus FREQUENCY

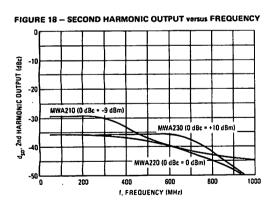












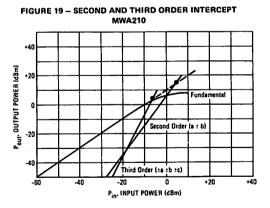


FIGURE 20 - SECOND AND THIRD ORDER INTERCEPT MWA220

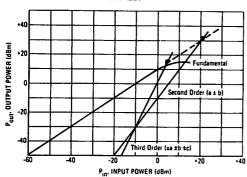


FIGURE 21 – SECOND AND THIRD ORDER INTERCEPT
MWA230

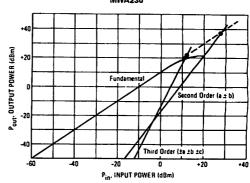


FIGURE 22 – INTERMODULATION DISTORTION versus
POWER OUTPUT MWA210

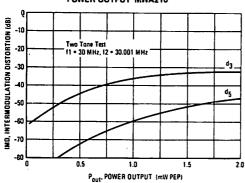


FIGURE 23 – INTERMODULATION DISTORTION versus POWER OUTPUT MWA220

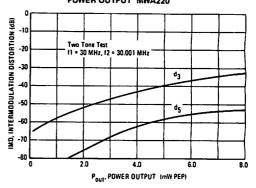


FIGURE 24 – INTERMODULATION DISTORTION versus POWER OUTPUT MWA230

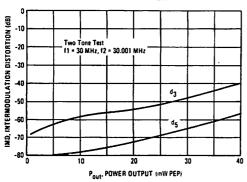
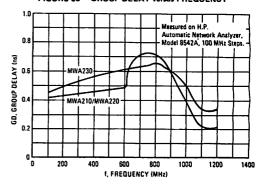


FIGURE 25 - GROUP DELAY versus FREQUENCY



MWA320 MWA330

MAXIMUM RATINGS Value MWA330

Symbol MWA310 MWA320 MWA330 Unit Rating mW Pin **RF Input Power** 100 mΑ 55 lp DC Supply Current °C 125 TC Maximum Case Temperature -65 to +200 °C Storage Temperature Range Tstg

OPERATING CONDITIONS

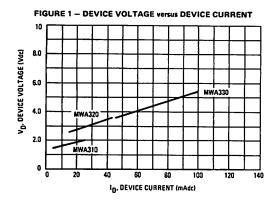
| Device Voltage | V _D | 1.6 | 2.9 | 4.0 | Vdc |
|----------------------|----------------|------|------|-----|------|
| Device Current | 1 _D | 10 | 25 | 60 | mAdc |
| Decoupling Impedance | ZD | 1000 | 1000 | 330 | Ω |

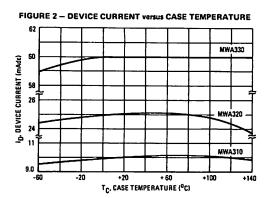
CASE 31A-01, STYLE 2
GENERAL PURPOSE HYBRID
AMPLIFIERS

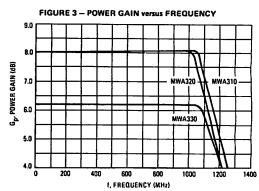
MWA310

ELECTRICAL CHARACTERISTICS (T_C = -25 to +80°C, 50 Ω system and specified operating conditions.)

| Characteristic Frequency Range | | Symbol | Min | Тур | Max | Unit |
|----------------------------------|--|-----------------|----------|------------------------|-------------|------|
| | | BW | 0.1 | | 1000 | MHz |
| Power Gain | MWA310/320 MWA330 | Gp | 7.0 — | 8.0 6.2 | | dB |
| Response Flatness | | F | | 0 | ±1.0 | ₫B |
| Input VSWR | | | | – 1 | 3:1 | |
| Output VSWR | | | | | 3:1 | |
| Output @ 1.0 dB Gain Compression | MWA310 MWA320 MWA330 | | | +3.5 +11.5 +15.2 | <u>-</u> | dBm |
| Noise Figure | MWA310 MWA320 MWA330 | NF | <u>-</u> | 6.5 6.7 9.0 | _ _ _ | dB |
| Reverse Isolation | MWA310 MWA320 MWA330 | PRI | | 10.4 10.4 9.0 | _ _ _ | dB |
| Harmonic Output | MWA310 (P _{OUt} = -9.0 dBm) MWA320 (P _{OUt} = 0 dBm) MWA330 (P _{OUt} = +10 dBm) | d _{SO} | = | -30 -38 -35 | _ _ _ | d₿ |







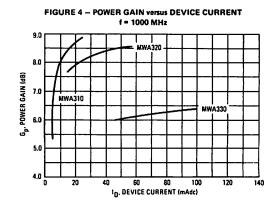


FIGURE 5 — POWER GAIN versus CASE TEMPERATURE f = 100 MHz

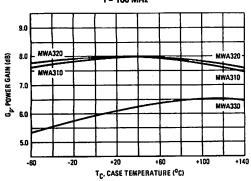


FIGURE 6 - POWER GAIN VERSUS CASE TEMPERATURE

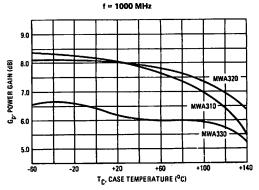


FIGURE 7 - VSWR versus FREQUENCY

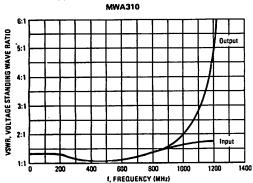


FIGURE 8 - VSWR versus FREQUENCY

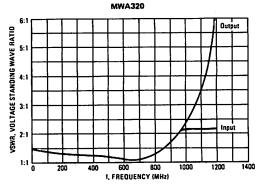


FIGURE 9 — VSWR versus FREQUENCY

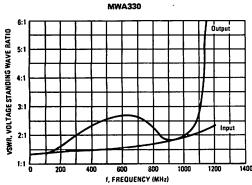
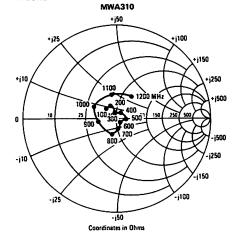


FIGURE 10 — INPUT IMPEDANCE versus FREQUENCY



-j25

FIGURE 11 — OUTPUT IMPEDANCE versus FREQUENCY

MWA310

+j50

+j100

+j25

+j100

1100

1200 MHz

+j250

+j500

25 500 PS 100 150 250 500

-j500

-j500

FIGURE 12 — INPUT IMPEDANCE versus FREQUENCY
MWA320

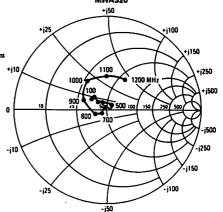
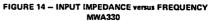
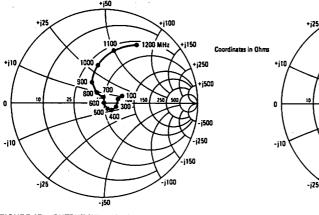


FIGURE 13 — OUTPUT IMPEDANCE versus FREQUENCY
MWA320





-j100

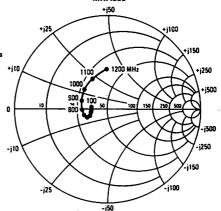
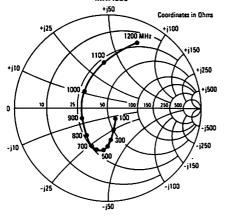


FIGURE 15 – OUTPUT IMPEDANCE versus FREQUENCY
MWA330

FIGURE 16 - 1.0 dB GAIN COMPRESSION versus FREQUENCY



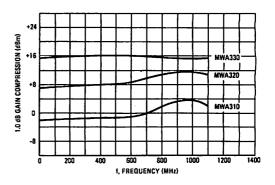
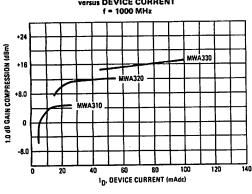
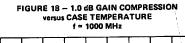


FIGURE 17 - 1.0 dB GAIN COMPRESSION versus DEVICE CURRENT





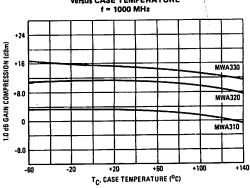


FIGURE 19 - NOISE FIGURE versus FREQUENCY

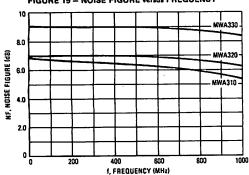


FIGURE 20 — REVERSE ISOLATION versus FREQUENCY

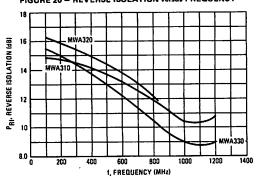


FIGURE 21 - SECOND HARMONIC OUTPUT vorsus FREQUENCY

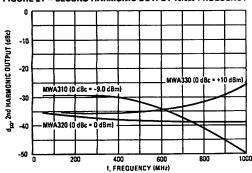


FIGURE 22 - SECOND AND THIRD ORDER INTERCEPT MWA310

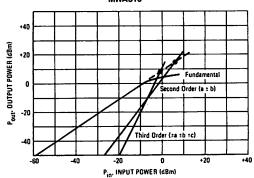


FIGURE 23 – SECOND AND THIRD ORDER INTERCEPT MWA320

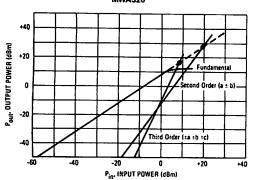


FIGURE 25 – INTERMODULATION DISTORTION versus POWER OUTPUT

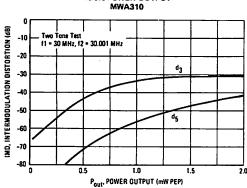


FIGURE 27 — INTERMODULATION DISTORTION versus POWER OUTPUT

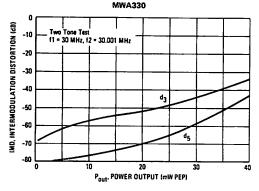


FIGURE 24 - SECOND AND THIRD ORDER INTERCEPT MWA330

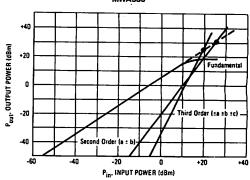


FIGURE 26 — INTERMODULATION DISTORTION

versus POWER OUTPUT

MWA320

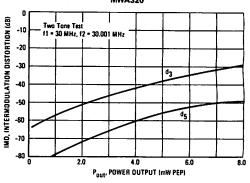
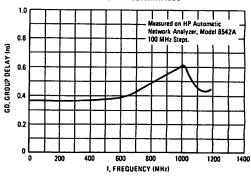


FIGURE 28 -- GROUP DELAY versus FREQUENCY MWA310/MWA320/MWA330



•

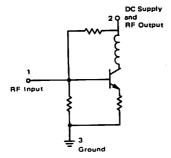
MWA SERIES HYBRID AMPLIFIER APPLICATIONS INFORMATION

The MWA series hybrid amplifiers are designed for wideband general purpose applications in $50~\Omega$ systems. Fully cascadable for any gain combination, operable at voltages as low as 3 Vdc, and external control of the low frequency corner make the MWA amplifiers extremely versatile gain blocks.

Basic Circuit Configuration

Figure 29 shows the basic internal circuit. It is important to note that the specified operating conditions of voltage, current, and external decoupling impedance must be applied to the units in order to achieve the published electrical characteristics.

FIGURE 29 - INTERNAL CIRCUIT



Amplifier Application

The circuit schematic for a simple amplifier design is shown in Figure 30. External to the MWA hybrid amplifier the only components required are:

Decoupling elements — Bypass Capacitor
Decoupling Impedance
(resistor/inductor)

DC Blocking Capacitors at the RF input and output.

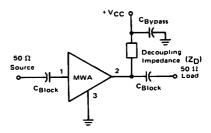
External Decoupling Impedance

In all cases the external bias (decoupling elements) must present an impedance which is large compared to the 50 Ω load impedance to minimize RF gain reduction. The loss in gain due to the decoupling impedance is given by the equation:

$$Loss = 20 Log \frac{Z_D}{Z_D + 25} dB$$

where Z_D = decoupling impedance in ohms. For example, if Z_D = 1 k Ω , Loss = 0.214 dB.

FIGURE 30 - AMPLIFIER SCHEMATIC DIAGRAM



Supply Voltage

The value of the external decoupling resistive impedance (RD) determines the supply voltage (+VCC) and is determined by the following equation:

where ID and VD are the device current and voltage stated in the data sheet. For example, for MWA110,

and, if RD = 330 Ω , then

More commonly V_{CC} is predetermined and R_D may be calculated from:

$$R_D = \frac{V_{CC} - V_D}{ID}$$

If an RF choke is used for decoupling, then the supply voltage (V_{CC}) required is equal to the device voltage (V_D).

Low Frequency Response

The value of the blocking capacitors determines the low frequency response of the amplifier. The following expression is used to determine the blocking capacitor value to yield a desired 3 dB low frequency corner (fLFC).

$$C_{Block}(Farads) = \frac{1}{100 \pi f_{1} FC(Hz)}$$

Bypass Capacitor

The reactive impedance of the bypass capacitor should be small compared to the impedance of the decoupling element at the lowest frequency of operation.

FIGURE 31 - TEST FIXTURE Grounding Screws Circuit Board 0 0 Mounted on Aluminum Block **Blocking Capacitor** (Ceramic Chip) 50 Ω Bulkhead Connector 0 Bias/Decoupling Impedance Bypass Capacitor + VCC Supply

Note: The circuitry indicated is on the underside of the printed circuit board with sockets for the amplifier pins. The case of the amplifier should contact the printed circuit board top surface to ensure effective RF grounding.

Text Fixture

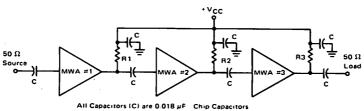
The 50 Ω -input/output impedance levels of the MWA hybrids are most easily preserved on a circuit board by using 50 Ω microstrip transmission lines. Figure 31 is an example of a circuit board layout which utilizes microstrip transmission lines in conjunction with other sound RF construction techniques.

The characteristic impedance and corresponding line width of the microstrip are a function of the circuit board dielectric constant and thickness. The table lists appropriate line widths for 50 Ω microstrip lines on commonly used circuit board materials.

| MATERIAL TYPE | DIELECTRIC CONSTANT | DIELECTRIC THICKNESS INCHES | LINE WIDTH INCHES |
|------------------|------------------------|-----------------------------------|-------------------------|
| Teflon- | 2.5 | 0.03125 | 0.090 |
| Fiberglass | | 0.0625 | 0.180 |
| Fiberglass- | 5.0 | 0.0625 | 0.100 |
| Epoxy | | | |

As in all good RF circuit designs, care should be taken to minimize parasitic lead inductances and to provide adequate grounding.

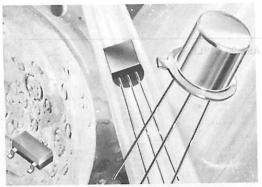
FIGURE 32 - TYPICAL CASCADE



Cascading

The inherent stability of the MWA hybrid modules makes possible the cascading of two or more units with no oscillatory problems. Figure 32 shows a typical 3 hybrid cascade with measured data for 400 MHz and 1000 MHz hybrids.

| | Cascade 1 | Cascade 2 |
|-----------------|-----------------|------------------|
| Frequency Range | 0.25 to 400 MHz | 0.25 to 1000 MHz |
| Gain | 43.5 dB | 20.5 dB |
| Gain Flatness | : 1.0 dB | ± 0.75 dB |
| Input VSWR | 2.0:ì | 2.4:1 |
| Output VSWR | 1.2:1 | 2.1:1 |
| VCC Supply | 12 Vdc | 33 Vdc |
| l Supply | . 44 mAdc | 150 mAdc |
| MWA =1 | MWA110 | MWA320 |
| MWA #2 | MWA110 | MWA330 |
| MWA #3 | MWA120 | MWA330 |
| R1 | 1000 Ω | 1000 Ω |
| R2 | 1000 Ω | 500 Ω |
| R3 | 300 Ω | 500 Ω |



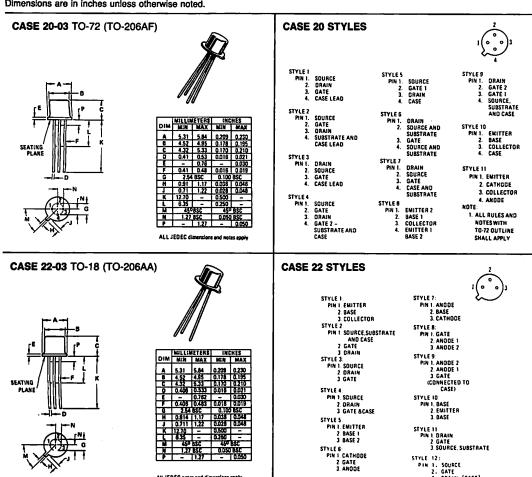
The following pages contain information on the various packages referenced on the individual data sheets. Information includes: a picture of the package, dimensions in both millimeters and inches, the various pinout configurations (styles), a cross reference for Case numbers, "old" JEDEC "TO" numbers, and the new JEDEC "TO" designation.

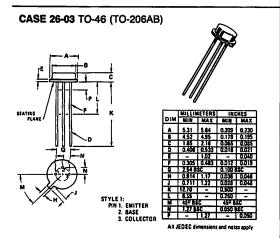
Additionally, abstracts of available application notes are provided. Please contact your local sales representative for those desired.

Package Outline Dimensions and Application Information

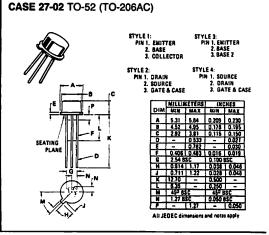
Package Outline Dimensions

Dimensions are in inches unless otherwise noted.

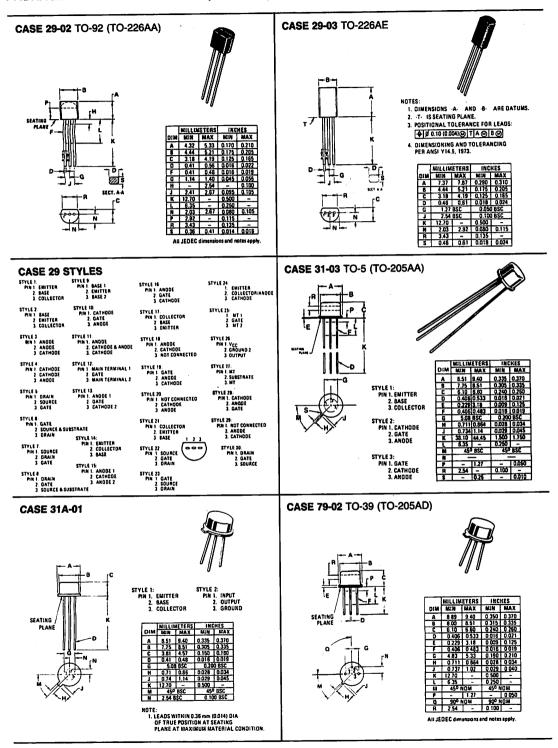




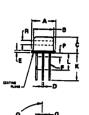
All JEDEC notes and dimensions apply.



STYLE 12: PIN 1. SOURCE 2. GATE 3. DRAIN (CASE)



CASE 79-03





| | MILLIMETERS | | the C | KE\$ |
|------|-------------|------|-------|-------|
| DIM | ACIN | MAX | MIN | MAX |
| A | 9.02 | 9.30 | 0.355 | 0.366 |
| 8 | 8.00 | 8.51 | 0.315 | 0.335 |
| 2 | 4.19 | 4.57 | 0.165 | 0.180 |
| | 0.43 | 0.53 | 0.017 | 0.021 |
| E | 0.43 | 0.83 | 0.017 | 0.035 |
| Ŀ | 0.41 | 0.48 | 0.016 | 0.019 |
| G | 4.83 | 5.33 | 0.180 | 0.210 |
| × | 0.71 | 0.65 | 0.028 | 0.034 |
| J | 0.74 | 3 | 0.029 | 0.040 |
| K | 12,70 | - | 0.500 | - |
| ш | | (CM | 4501 | (CM |
| | 2.54 | TYP | 0,100 | TYP |
| ∟Q⊺I | 900 (| CM | 900 1 | ICM |

CASE 79 STYLES



STYLE 1: PIN 1. EMITTER 2. BASE 3. COLLECTOR STYLE 4: PIN 1. MAIN TERM, 1 2. GATE 3. MAIN TERM, 2

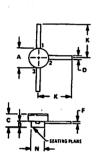
STYLE 2: PIN 1. DRAIN 2. SOURCE 3. GATE STYLE 5: PIN 1. COLLECTOR 2. BASE 3. EMITTER

STYLE 3: PM 1. CATHODE 2. GATE 3. ANODE STYLE 6: PIN 1. SOURCE 2. GATE 3. GRAIN (CASE)

NOTES.

1. ALL RULES AND NOTES ASSOCIATED WITH TO:39
OUTLINE SHALL APPLY.

CASE 176-02

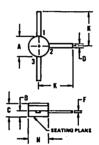




NOTE:
A Tolerance of .25 mm (.010) must be allowed at point bads protrude from package for glass run over.

| | MILLIMETERS | | LNC | KES |
|-----|-------------|-------|-------|-------|
| DIM | MIN | MAX | MIN | MAX |
| LA. | 2.03 | 2.67 | 0.080 | 0.105 |
| . 8 | 0.38 | 0.76 | 0.015 | 0.030 |
| C | 1.27 | 2.03 | 0.050 | |
| | 0.25 | 0.41 | 0.010 | 0.018 |
| Œ | 0.68 | 0.15 | 0.003 | 0.006 |
| K | 4.06 | _4.57 | 0.160 | 0.180 |
| N | 1.47 | 1.78 | 0.058 | 0.070 |

CASE 176B-01





| | MILLIMETERS | | INC | KES |
|-----|-------------|-------|-------|-------|
| DIM | MCTAN | MAX | MCIA | MAX |
| A | 2.03 | 2.67 | 0.080 | 0.105 |
| | 0.38 | 0.78 | 0.015 | 0.030 |
| | 1,27 | 2,03 | 0.050 | 0.080 |
| | 0,25 | 0,41 | 0.010 | 0.018 |
| Œ | 8 | 0.015 | 8 | 0.006 |
| LK | 4.06 | 4.57 | 0,150 | 0.180 |
| _ N | 2.03 | 2.67 | 0.030 | 0.105 |

CASE 176 STYLES

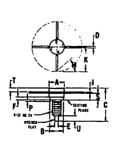


STYLE 5:
PIN 1. CATHODE
2. NOT CONNECTED
3. ANODE

STYLE 6:
PIN 1. CATHODE

STYLE 6:
PIN 1. CATHODE
2. ANGGE
3. ANGDE
STYLE 7:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

CASE 244A-01

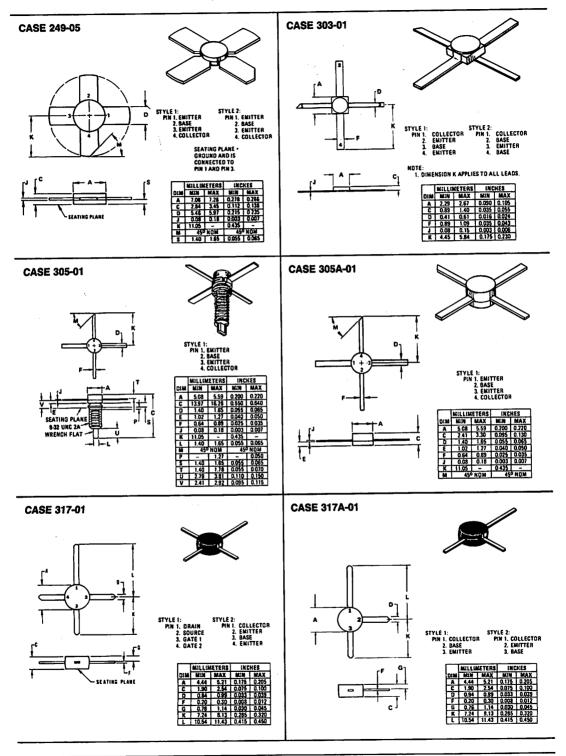


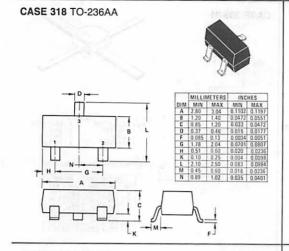


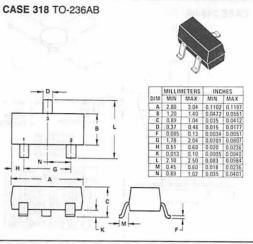
*STYLE 1: STYLE 2: PIN 1. EMITTER PIN 1. COMMON 2. BASE 2. OUTPUT 3. EMITTER 3. COMMON 4. COLLECTOR 4. INPUT

| 1 | MILLIMETERS | | INC | HES |
|-----|-------------|-------|-------|-------|
| DIM | MIN | MAX | MCIN | MAX |
| A | 7.06 | 7.26 | 0.278 | 0.288 |
| 8 | 6.20 | 8.50 | 0.244 | 0.256 |
| C | 15,24 | 18.51 | 0.600 | 0.650 |
| 0 | 0.68 | 0.86 | 0.026 | 0.034 |
| E | 1.40 | 1.65 | 0.055 | 0.065 |
| F | 1,52 | ļ | 0.060 | |
| 1 | 0.10 | 0.15 | 0.004 | 0.006 |
| K | 11.17 | - | 0.440 | - |
| M | 450 | NOM | 450 | NOM |
| P | _ | 1,27 | - | 0.050 |
| S | 2,74 | 3.35 | 0.108 | 0.132 |
| T | 1.40 | 1.78 | 0.055 | 0.070 |
| U | 2.92 | 83.8 | 0.115 | 0.145 |

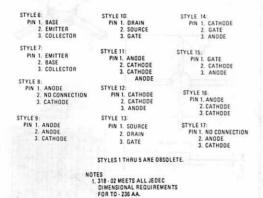
PACKAGE OUTLINE DIMENSIONS (continued)

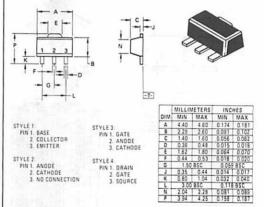






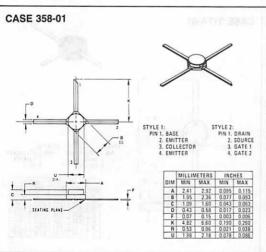


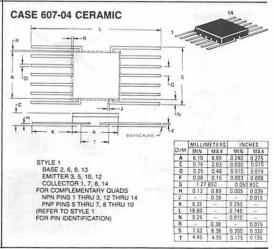


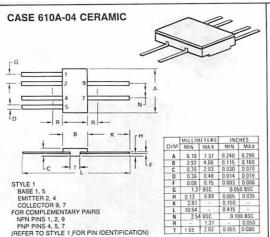


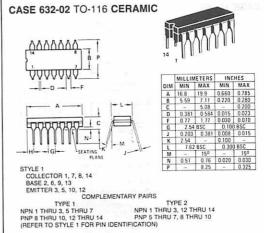
CASE 345-01

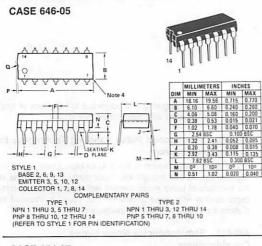
3. NO CONNECTION

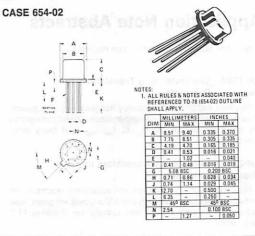


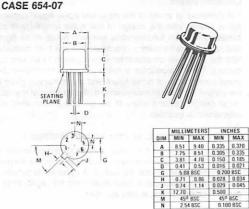








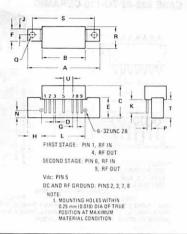


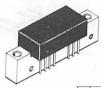




CASE 654 STYLES

CASE 714-02





| | MILLIMETERS | | INC | HES |
|-----|-------------|-------|-----------|-------|
| DIM | MIN | MAX | MIN | MAX |
| A | - | 45.08 | - | 1.775 |
| В | 25.42 | 26.92 | 1.040 | 1.050 |
| C | 20.57 | 21.34 | 0.810 | 0.840 |
| D | 0.46 | 0.56 | 0.018 | 0.022 |
| E | 11.81 | 12.95 | 0.465 | 0.510 |
| F | 7.62 | 8.13 | 0.300 | 0.320 |
| G | 2.41 | 2.67 | 0.095 | 0.105 |
| Н | 9.65 | 9.78 | 0.380 | 0.385 |
| J | 3.96 | BSC | 0.156 BSC | |
| K | 6.86 | 7.37 | 0.270 | 0.290 |
| L | 25.4 | 3 BSC | 1.000 | BSC |
| N | 4.06 | 4.32 | 0.160 | 0.170 |
| P | 2.16 | 2.92 | 0.085 | 0.115 |
| a | 3.76 | 4.27 | 0.148 | 0.158 |
| R | | 15.11 | - | 0.595 |
| S | 38.10 | BSC | 1.50 | DBSC |
| T | 11.05 | 11.43 | 0.435 | 0.450 |
| U | 4.95 | 5.21 | 0.195 | 0.205 |

Application Note Abstracts

(Application Notes are available upon request.)

AN-139A Understanding Transistor Response Parameters

This note explains high-frequency transistor response parameters and discusses their interdependence. Useful nomograms are given for determining $h_{fe},\ f_{T},\ f_{\alpha e},\ f_{max},$ and many other parameters.

AN-211A Field-Effect Transistors in Theory and Practice

The basic theory, construction, and application information for field-effect transistors (junction and MOS types) are given. Also included are some typical test circuits for checking FET parameters.

AN-215A RF Small-Signal Design Using 2-Port Parameters

Power gain and stability of high-frequency transistors may be completely described by two port parameters.

This paper presents a summary of the overall design solution for the small-signal RF amplifier using two-port parameters. Design considerations and relationships for both the stable and the potentially unstable transistor are presented together with a discussion of neutralized, unneutralized, matched, and mismatched amplifiers.

AN-267 Matching Network Designs with Computer Solutions

Computer solutions for four networks commonly used in solidstate high frequency amplifiers have been tabulated.

AN-268 Pulse Triggering of Radar Modulator SCR's

Factors involved in dynamic gate triggering are examined and

relations of gate triggering characteristics to variations of total current amplifications with gate current are shown.

AN-270 Nanosecond Pulse Handling Techniques in IC Interconnections

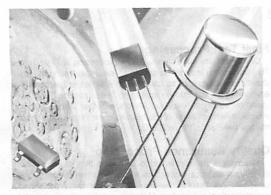
The rapid advancement in the field of high speed digital integrated circuits has brought into focus many problem areas in the methods of pulse measurement techniques and new concepts dealing with these problems. This paper is intended to discuss the more common, yet perhaps not well

AN-421 Semiconductor Noise Figure Considerations

A summary of many of the important noise figure considerations related with the design of low noise amplifiers is presented. The basic fundamentals involving noise, noise figure, and noise figure-frequency characteristics are then discussed with the emphasis on characteristics common to all semiconductors. A brief introduction is made to various methods of data sheet presentation of noise figure and a summary is given for the various methods of measurement. A discussion of low noise circuit design, utilizing many of the previously discussed considerations, is included.

EN-101 Verifying Collector Voltage Ratings

Methods of verifying the various voltage ratings given on transistor data sheets are described. Practical test circuits are given and testing problems are discussed. A detailed discussion of the avalanche breakdown mechanism and the significance of various voltage ratings is also included.



Discrete products are available from Motorola in three quality levels: Industrial/Commercial grade, Military grade, and Customer Specials.

This Reliability and Quality Assurance section contains information on final test and quality assurance processing. Included is a listing of Q.A. tests and the applicable MIL-STD methods relating to the above-noted quality levels.

High reliability (JAN, JANTX, JANTXV, and JANS) processing of transistors is outlined by using a processing and quality control flow chart.

A glossary of Reliability and Quality terms is also included.

Reliability and Quality Assurance

Reliability and Quality Assurance

Quality Levels

Most small-signal discrete products are available from Motorola in three quality levels:

- INDUSTRIAL/COMMERCIAL GRADE Identified by a part number prefix such as 2N, MM or MPS and tested to a published Motorola, JEDEC or Proelectron specification.
- MILITARY GRADE Identified by a 2N part number prefix, a JAN, JTX, JTXV or JANS suffix, and manufactured and tested per MIL-S-19500.
 - JAN Controlled lot with sample environmental and life testing
 - JTX Same as JAN plus 100% processing
 - JTXV Same as JTX plus 100% internal visual inspection
 - JANS— Same as JTXV plus wafer lot acceptance and additional 100% processing requirements.
- CUSTOMER SPECIAL Screening, testing and marking as determined by the customer to meet his particular requirements. This may range from a custom-marked industrial/commercial grade product to a hi-rel product which is subjected to a series of stringent inspections and tests to meet aerospace or special military requirements.

Final Test Processing

Device lots are subjected to 100% processing in Final Test. This processing may be as simple as electrical testing to data sheet specifications or as complex as a series of mechanical, environmental and burn-in screening tests preceded and followed by electrical readouts. All lots, whether industrial/commercial, military or hi-rel, are subjected to a minimum eight-hour storage bake at 150°C or 200°C.

Quality Assurance Processing

All products are transferred to QA where they are subjected to Group A electrical testing, usually to the same specifications used by Final Test. In the past, QA has primarily performed sample testing; but now, at Motorola, most small-signal metal can transistors are 100% electrical tested by QA, and when this expansion program is completed, all small-signal transistors will be subjected to 100% QA electrical testing. Military and hi-rel lots may undergo additional 100% screening in QA. Using the popular 2N2222A family as an example, Table 1 compares the varying degrees of preconditioning and screening that are done on the 2N2222A, 2N2222AJAN, 2N2222AJTX, 2N2222AJTXV and 2N2222AJANS transistors. QA randomly selects test samples for Group A, B and C testing as defined in MIL-S-19500. The individual tests are defined in MIL-STD-750. Tables 2 and 3 list the Group B and C test requirements for the 2N2222A military family.

TABLE 1 — 100% PRECONDITIONING AND SCREENING (2N2222A Family)

| Test | MIL-STD-750 Method | Condition | 2N2222A 2N2222AJAN | 2N2222AJTX 2N2222AJTXV | 2N2222AJANS |
|---|-----------------------|-----------------|-----------------------|---------------------------|-------------|
| 1. Electrical tests | _ | go – no go | 100% | 100% | 100% |
| 2. High temperature storage | 1032 | 200°C, 24 hours | 1 – | 100% | 100% |
| 3. Thermal shock | 1051 | C, 20 cycles | | 100% | 100% |
| 4. Constant acceleration | 2006 | 20,000 G, Y1 | l - | 100% | 100% |
| Particle Impact noise Hermetic seal | 2052 | В | - | _ | 100% |
| fine leak | 1071 | G or H | _ | 100% | 100% |
| gross leak | 1071 | A, C, E or F | l – | 100% | 100% |
| 7. Electrical tests | l – | read & record | | | 100% |
| 8. H.T. reverse bias | 1039 | 150°C, 48 hours | l – | 100% | 100% |
| 9. Electrical tests | _ | read & record* | l – | 100% | 100% |
| Full-power burn-in | 1039 | 25°C, 168 hours | _ | 100% | _ |
| 11. Full-power burn-in | 1039 | 25°C, 240 hours | _ | _ | 100% |
| 12. Electrical tests | <u> </u> | read & record* | _ | 100% | 100% |
| 13. Hermetic seal | | | | | |
| fine leak | 1071 | G or H | _ | 100% | 100% |
| gross leak | 1071 | A, C, E or F | _ | 100% | 100% |
| 14. X-ray | 2076 | | _ | | 100% |
| 15. External visual | 2071 | l – | _ | | 100% |

^{*}Bin & cell may be used for JTX and JTXV product

TABLE 2 — GROUP B TESTS (2N2222AJAN/JTX/JANS)

| Inspection or Test | MIL-STD-750 Method | Condition | LTPD (Accept No.) and Military Classification |
|-----------------------------------|-----------------------|-------------------|--|
| SUBGROUP LTPD | - | • | 10 (0) |
| Physical dimensions | 2066 | | JANS |
| SUBGROUP LTPD | l ' | | 15(1) |
| 2. Solderability | 2026 | _ | ALL |
| 3. Solvent resistance | 1022 | _ | ALL |
| SUBGROUP LTPD | | | 10 (1) |
| 4. Thermal shock | 1051 | C1, 25 cycles | VXTL, JTX, JAL |
| Thermal shock | 1051 | C3, 100 cycles | JANS |
| 5. Hermetic seal | | | |
| fine leak | 1071 | G or H | ALL |
| gross leak | 1071 | A, C, E or F | ALL |
| 6. Decap internal visual | 2075 | 1 - 1 | JANS |
| 7. Bond strength | 2037 | A | JANS |
| 8. Die shear | 2017 | _ | JANS |
| SUBGROUP LTPD | | | 5 (2) |
| 9. Operating life | 1027 | 25°C, 340 hours | JAN, JTX, JTXV |
| SUBGROUP LTPD | | | 20 (0) |
| 10. Decap internal visual | 2075 | - | JAN, JTX, JTXV |
| 11. Bond strength | 2037 | A | JAN, JTX, JTXV |
| SUBGROUP LTPD | ľ | 1 | 10 (2) |
| 12. Intermittent operating life | 1037 | 25°C, 2000 cycles | JANS |
| SUBGROUP LTPD | | | 10 (2) |
| 13. Accelerated operating life | 1027 | 125°C, 96 hours | JANS |
| SUBGROUP LTPD | 1 | | 7 (2) |
| 14. High-temperature storage life | 1032 | 200°C, 340 hours | JAN, JTX, JTXV |

TABLE 3 — GROUP C TESTS (2N2222AJAN/JTX/JTXV/JANS)

| Inspection or Test | MIL-STD-750 Method | Condition | LTPD (Accept No.) and Military Classification |
|---------------------------------------|-----------------------|-----------------------|--|
| SUPGROUP LTPD | | | 15 (1) |
| Physical dimensions SUBGROUP LTPD | 2066 | _ | ALL 10 (1) |
| 2. Thermal shock | 1056 | A E | ALL |
| 3. Terminal strength | 2036 | E | ALL |
| 4. Hermetic seal | | | |
| fine leak | 1071 | G or H | ALL |
| gross leak | 1071 | A, C, E or F | ALL |
| 5. Moisture resistance | 1021 | Omit initial precond. | ALL |
| 6. External visual | 2071 | _ | ALL. |
| SUBGROUP LTPD | | | 10 (1) |
| 7. Shock | 2016 | 1500G | ALL |
| 8. Variable-frequency vibration | 2056 | 100-2000 Hz | ALL |
| 9. Constant acceleration | 2006 | 20,000 G | ALL |
| SUBGROUP LTPD | | | 15 (1) |
| 10. Salt atmosphere | 1041 | - | ALL |
| SUBGROUP LTPD | | | 10 (1) |
| 11. Operating life | 1026 | 25°C, 1000 hours | ALL |

High Reliability Processing of Transistors

I WAFER PROCESSING

After waters are processed, they are subjected to Motorola visual inspection requirements and overlay geometry waters are subjected to a sample SEM inspection to assure good stop coverage. The waters are then probed to electrical requirements and the rejects are Inked. Finally, they are sawn and separated to form the Inkidukual dice.

II ASSEMBLY

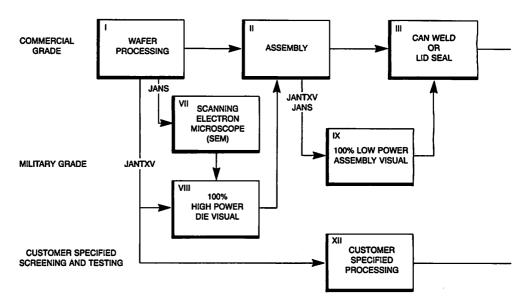
The die are attached to headers and then wire bonded. The following mechanical tests are performed by Quality Control inspectors on a sample basis to ensure assembly process controls.

- (1) Wire pull tests
- (2) Die push off tests
- Units are stored in dry air until ready for capping.

III CAN WELD OR LID SEAL

Completed headers are loaded into a vacuum chamber for can weld or processed thru a furnace for top attachments on ceramic packages. All devices are subjected to a high temperature storage (stabilization bake) prior to final electrical test.

PROCESSING AND QUALITY CONTROL FLOW CHART



VII SCANNING ELECTRON MICROSCOPE

All JANS product with overlay geometry requires a SEM inspection per Mill-STD-750, method 2077. To assure good metallization step coverage, Motorola monitors all overlay geometry transistor wafer lines whether or not it is required.

XII CUSTOMER SPECIFIED PROCESSING

Screening, testing and manking as determined by the customer to meet his particular requirements, which may range from a custom-marked standard product to a hi-rel product that is subjected to the most stringent tests for serospace or military assistance.

VIII 100% HIGH POWER DIE VISUAL

The high power portion of the inspection is performed to assure good die construction and front metal conditions. Individual reject critoria includes the following: Metalization defects such as scratches, voids, corrosion, adherence, bridging and alignment. Poor die construction conditions such as exide and faults are also rejected.

IX 100% LOW POWER ASSEMBLY VISUAL

The low power visual inspection controls workmanship, i.e., die attachment, internal lead-wire attachment, and package defects. Die attachment inspection includes assuring good waiting, die placement and proper orientation, Internal lead wires must have proper are and all attachment bonds must be property placed and in good condition. Package defect inspection includes checking for foreign material, improper construction and cracked feedbroughs.

IV 100% FINAL ELECTRICAL TEST

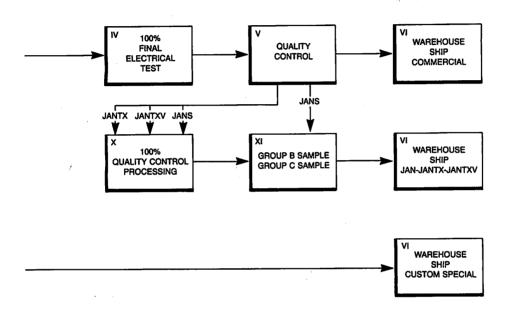
Completed devices are subjected to 100% testing to electrical requirements. When different devices are sourced from a single product line, they are sorted for voltage and gain.

V QUALITY CONTROL

Although it has been traditional for QA to perform sample testing. today most small-signal metal can transistors are 100% electrical tested by QA. Soon, all transistors will be 100% tested by QA. Group A and B tests are performed on JAN devices. Group A and B tests and 100% processing are performed on JANTX, JANTXV and JANS devices. Group C testing is required on a

VI WAREHOUSE

Upon completion, the finished product is ready for shipping. Purchase order requirements are carefully checked again prior to shipping. Warranty tests (Group A) are performed every 24 months on military devices.



X 100% QUALITY CONTROL PROCESSING

- High-temperature storage
- Thermal shock Constant acceleration
- Particle impact noise (JANS)
- Hermetic seal
- ŧ. High-temperature reverse bias Full-power burn-in
- g. h.
- X-ray (JANS)
- External visual (JANS)
- Read and record parameters

XI GROUP B AND GROUP C INSPECTION

Typical Group B Processing Typical Group C Processing

h.

- a. Physical dimensions
- Solderability Solvent resistance
- Thermal shock d.
- Hermetic seal e.
- Decap internal visual
- g. Bond street Bond strength
- 340 hr. operating life Intermittent operating life j.

- (JANS)
- i. 340 hr. storage life

- a. Physical dimensions Thormal shock
- C. Terminal strength
- d. Hermetic seal
- Moisture resistar o. 1.
- External visual
- Shock Variable-frequency
- vibration Constant acceleration
- Salt atmosphere i.
- k. 1000 hr. operating life

Test Descriptions

The following tests are frequently used for screening, acceptance and evaluation of semiconductor devices.

A. Steady State Operating Life (SSOL)

The purpose of this test is to evaluate the bulk stability of the die and to generate defects resulting from manufacturing aberrations that are manifested as time and stressdependent failures.

Conditions: $T_{\Delta} = 25^{\circ}C$, PD = max rated power

B. Intermittent Operating Life (IOL)

The purpose of this test is the same as Operating Life in addition to checking the integrity of both the wire and die bonds by means of thermal stressing.

Conditions: $T_A = 25$ °C, PD = max rated power. $T_{(on)} = T_{(off)} = 1$ min.

C. High Temperature Storage Life

The purpose of this test is to generate time/temperature failure mechanisms and to evaluate long-term storage stability.

Conditions: T_A = 150°C no bias applied

D. High Temperature Reverse Bias (HTRB)

The purpose of this test is to align mobile ions by means of temperature and voltage stresses to form a high-current leakage path between two or more terminals.

Conditions: TA = 150°C, VCB = 80% max rated VCB,

E. High Temperature High Humidity Reverse Bias (H³TRB)

The purpose of this test is to evaluate the moisture resistance of non-hermetic components. The addition of voltage bias accelerates the corrosive effect after moisture penetration has taken place. With time, this is a catastrophically destructive test

Conditions: $T_A = 85^{\circ}C$, RH = 85%, $V_{CB} = 80\%$ max rated V_{CB} ,

F. Moisture Resistance

The purpose of this test is to evaluate the moisture resistance of components under temperature/humidity conditions typical of tropical environments.

Conditions: Mil-Std-750, Method 1021.

G. Pressure Cooker

The purpose of this test is to evaluate the moisture resistance of non-hermetic components under pressure/temperature conditions.

Conditions: T = 121°C, P = 1 atmosphere (15 psig)

H. Temperature Cycle (Air to Air)

The purpose of this test is to evaluate the ability of the device to withstand both exposure to extreme temperatures and the transition between temperature extremes, and to expose excessive thermal mismatch between materials.

Conditions: Mil-Std-750, Method 1051, -55°C to 150°C, 15 minutes dwell time at each temperature

I. Thermal Shock (Liquid to Liquid)

This test is an accelerated version of temperature cycle.

Conditions: Mil-Std-750, Method 1056, 0°C to 100°C, 15 seconds dwell time at each temperature

J. Terminal Strength

The purpose of this test is to evaluate the ability of the device terminals to withstand the lead forming and tension associated with component installation into a circuit.

Conditions: Mil-Std-750, Method 2036, Condition E.

K. Solderability

The purpose of this test is to determine the solderability of the device terminals.

Conditions: Mil-Std-750, Method 2026.

L. Salt Atmosphere (Corrosion)

The purpose of this test is to accelerate the corrosion effects of an environment in which salt (NaC1) is present.

Conditions: Mil-Std-750, Method 1041

M. Mechanical Stress Tests

Vibration, shock and constant acceleration tests are infrequently used since they rarely generate failures in smallsignal transistors. However, they are still specified for acceptance of military product.

Glossary of Reliability and Quality Terms

Acceptable Quality Level (AQL) — A measure of quality for which a given lot will be accepted most of the time. This is usually established at a probability of acceptance equal to 95%. It is referred to as the producer's risk because the probability of rejecting a good lot is 5%.

Acceptance Number (Ac) — The largest number of defectives in an inspection sample under consideration that will permit acceptance of the lot.

Acceptance Tests — Tests to determine conformance to specification requirements as a basis for lot acceptance.

Average Outgoing Quality (AOQ) — The average quality of outgoing product after 100% screening of rejected lots. This is usually measured in parts per million (PPM).

Average Outgoing Quality Limit (AOQL) — The maximum average outgoing quality that is possible for a given sampling plan.

Defect — Any deviation of a device that does not conform to specified requirements. One device may contain more than one defect.

Defective - A device which contains one or more defects.

Double Sampling — Sampling inspection in which the inspection of the first sample leads to a decision to accept, to reject, or to take a second sample. The inspection of a second sample, when required, always leads to a decision to accept or to reject.

Failure — The inability of a device to perform a specified function within previously-established limits.

Failure Rate — The statistical probability of a failure occurring within a stated period of time. For electronic components it is usually assumed that failures follow an exponential distribution, in which case the failure rate over any stated period of time is constant. The failure rate of semiconductor devices is generally given in percent per thousand hours.

Infant Mortality — Premature failures occurring at a failure rate substantially greater than that observed during subsequent life prior to wear-out.

Lot — A group of devices from which samples are drawn and inspected to determine compliance with acceptance criteria (inspection lot).

Lot Tolerance Percent Defective (LTPD) — A measure of quality for which a given lot will be rejected most of the time. This is usually established at a probability of acceptance equal to 10%. It is referred to as the consumer's risk because the probability of accepting a bad lot is 10%.

Mean Time Between Failures (MTBF) — The total measured operating time of a group of equipments divided by the total number of failures of a repairable equipment. In the case of an exponential failure distribution, this ratio is the reciprocal of failure rate.

Operating Characteristic Curve (OC curve) — A graph of the probability of acceptance as a function of the lot quality or process average quality, whichever is applicable.

Percent Defective — The number of defective devices in a lot divided by the total number of devices in that lot, multiplied by 100.

Probability of Acceptance (Pa) — The fractional probability that a lot will be accepted, usually expressed as a decimal.

Process Average Quality — The expected quality of product from a given process, usually estimated from first sample results of previous inspection lots.

Quality — A measure of the degree to which a product conforms to specification and workmanship requirements.

Rejection Number (Re) — The smallest number of defectives in an inspection sample under consideration that will prevent acceptance of the lot.

Reliability — A measure of the performance of a product over a specified period of time.

Sample — One or more devices selected at random from an inspection lot to represent that lot for acceptance purposes.

Sampling Plan — A specific plan which defines the sample size and the criteria for accepting or rejecting a lot.

Screening Tests — Tests employing nondestructive environmental, electrical, thermal and/or mechanical stresses, for the purpose of identifying anomalous devices.

Single Sampling — Sampling inspection in which a decision to accept or to reject is reached after the inspection of a single sample.

Wearout Failures — Those failures which occur as a result of deterioration processes and whose probability of occurrence increases with time.

100% Inspection — Inspection of every device, in which each device is accepted or rejected individually for the characteristic concerned, on the basis of its own inspection only.

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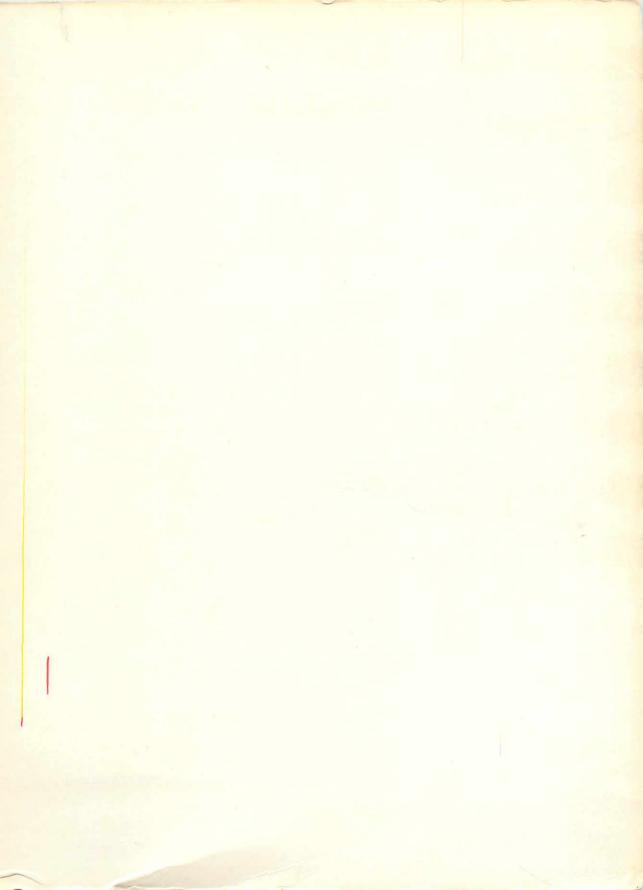
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